# EXHIBIT C

**IN THE UNITED STATES DISTRICT COURT**
**FOR THE EASTERN DISTRICT OF TEXAS**
**MARSHALL DIVISION**

| | |
|---|---|
| **GEODYNAMICS, INC.,**<br><br>**Plaintiff,**<br><br>**v.**<br><br>**DYNAENERGETICS US, INC.,**<br><br>**Defendant.** | **Civil Action No. 2:17-cv-00371-RSP**<br><br>**JURY TRIAL** |

# REBUTTAL EXPERT REPORT OF DR. GARY WOOLEY REGARDING THE VALIDITY OF U.S. PATENT NO. 8,220,394

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# 1. Introduction

## 1.1 Summary of Opinions

1. I have been engaged by GEODynamics, Inc. to provide testimony on certain issues in the above styled lawsuit. I have been asked to address the issue of validity of U.S. Patent No. 8,220,394 ("the '394 patent"). Specifically, I have been asked to provide opinions in response to the opinions set forth in the Expert Reports of James Brooks and Tod Tumey.

2. Based on my investigation in this matter, I have concluded that none of the references or combinations of references in Dr. Brooks' Report render obvious any of the Asserted Claims of the '394 patent. I have also concluded that the '394 patent is not invalid for lack of written description. Further, based on my understanding of the law, it is my opinion that the applicants of the '394 patent did not engage in inequitable conduct, because the data submitted in both prosecutions separately supports the patentability of both patents. In this report, I explain how I arrived at these opinions, as well as other opinions and findings.

## 1.2 Personal Background

3. I provided my personal background in my opening expert report. I incorporate that description herein by reference.

## 1.3 My Investigation regarding the Validity of the Patents-in-Suit

4. I understand that GEODynamics is asserting infringement of claims 1, 2, 3, and 28 of the '394 patent ("Asserted Claims"). This rebuttal expert report provides my opinions in rebuttal to the allegations of invalidity and nonobviousness of the Asserted Claims set forth in Dr. Brooks' opening report. My silence as to any portion of these reports does not indicate that I agree with the opinions expressed therein. To address the opinions set forth in those reports, I studied and considered a variety of facts and evidence, including at least the following sources: the '394 patent and it prosecution history; the prior art references identified in Dr. Brooks'

report, papers in this litigation—including briefs written by the parties, the Court's Claim Construction Order, and written discovery and responses (including appendices and exhibits accompanying the written discovery responses); the invalidity contentions served by Dyna in this case; the *Inter Partes* Review papers for IPR2017-02008 initiated by Dyna challenging the patentability of the '394 patent; and the deposition transcripts and exhibits. Naturally, my review of these materials was informed by my education, my experience in and knowledge of industry, and my employment as an engineering professor.

## 2. Legal Standards Applied in This Report

5. I am informed that the following legal principles apply to the subject matter of this report.

6. The patent claims describe the invention made by the inventors and describe what the patent owner owns and what the owner may prevent others from doing. Claims may describe products, such as machines or chemical compounds, or processes for making or using a product. Claims are usually divided into parts or steps called limitations or elements.

7. There are two types of claims: independent claims and dependent claims. An independent claim sets forth all the requirements that must be met in order to be covered by that claim. Thus, it is not necessary to look at any other claim to determine what an independent claim covers. A dependent claim does not itself recite all of the requirements of the claim, but refers to another claim for some of its requirements. In this way, the claim depends on another claim. The law considers a dependent claim to incorporate all of the requirements of the claims to which it refers. The dependent claim then adds its own additional requirements. To determine what a dependent claim covers, it is necessary to look at both the dependent claim and any other claims to which it refers.

8. In that case, the dependent claims incorporate the limitations of the independent claim upon which they depend and, if a reference fails to disclose any of the limitations of an independent claim, the claims which depend on that claim cannot be made invalid by that reference. As a result, any of the references discussed in the Opening Invalidity Reports that fail to disclose all of the limitations of an independent claim necessarily also fail to disclose all of the limitations of the Asserted Claims which depend on that claim.

### 2.1 Presumption of Validity

9. It is my understanding that the claims of an issued patent are presumed to be valid.

### 2.2 Burden of Proving Invalidity

10. It is my further understanding that Dyna has the burden of proving invalidity through facts supported by clear and convincing evidence. I understand that the "clear and convincing evidence" standard means evidence that produces in the mind of the judge or the jury, as the case may be, an abiding conviction that the truth of a factual contention is highly probable. As explained in the remainder of this rebuttal expert report, it is my opinion that the Opening Invalidity Reports fail to meet that level of proof in alleging that the Asserted Claims of the Patents-in-Suit are invalid.

### 2.3 Level of Ordinary Skill in the Art

11. I understand that a person having ordinary skill in the art may be defined by factors such as: (a) the levels of education and experience of the inventor and other persons actively involved in the field; (b) the types of problems encountered in the field; (c) prior art solutions to those problems; (d) rapidity with which innovations are made; and (e) the sophistication of the technology.

12. As I described in my previous report, I believe a person of ordinary skill in the art at the time the '394 patent was filed would have had a Bachelor of Science in an engineering or

science discipline, and five years of experience working in the oil and gas industry with respect to perforating design and fabrication and well completion activities including perforation.

13. Dr. Brooks opined that a person of ordinary skill in the art of the '394 patent would have an advanced degree in petroleum or mining engineering, mechanical engineering, or a comparable discipline, and at least five years of experience in shaped charge development, or an equivalent combination of education and experience.[1]

14. It is my opinion that the levels of ordinary skill in the art identified by myself and Dr. Brooks are equivalent. In my opinion, the '394 patent is valid under either my or Dr. Brooks' proposed level of ordinary skill in the art.

### 2.4 The Court's Constructions of the Claims of the '394 Patent

15. I have reviewed the claim construction briefs submitted by both parties. I have also reviewed the Court's Claim Construction Order. I have applied the Court's constructions to my analysis in this report. For claim language that has not been construed, I understand that such claim language is to be given its ordinary and accustomed meaning as understood by one of skill in the art. The following chart lists the terms construed by the Court in its May 8, 2018 claim construction memorandum.

| **Claim Term/Phrase** | **Construction** |
|---|---|
| "exothermic reaction"<br>(Claim 1, 28) | "a chemical reaction resulting in the release of heat" |

[1] Note that Dr. Brooks also opines that "[a] skilled shaped-charge designer of 2003 should have at least five years hands-on experience in the manufacture and design of shaped charges used for downhole perforating, and would have designed and developed at least one successful commercial shaped charge for the field from initial conception to commercialization. He should also have a BS degree in mechanical engineering or its equivalent, and a demonstrated understanding of shaped-charge physics and attendant skills in experimental and manufacturing techniques used in developing shaped charges." Brooks Report at ¶ 16. It is unclear why Dr. Brooks provided an alternative definition for a skilled artisan. Nevertheless, it is my opinion that the '394 patent is valid under either of Dr. Brooks' interpretations.

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|---|---|
| "green compacted particulate"<br>(Claim 1, 28) | "a pressed powder that has not been further strengthened as by sintering" |
| "intermetallic alloying reaction"<br>(Claim 1) | "a reaction between the at least two metal elements that forms an intermetallic compound" |
| "intermetallic alloying reaction"<br>(Claim 28) | "a reaction between the two metal elements that forms an intermetallic compound" |
| "electron concentration"<br>(Claim 1, 28) | "a ratio of valence electrons to atoms" |
| "at least two metal elements are provided in respective proportions calculated to give an electron concentration of 1.5"<br>(Claim 1) | "at least two metal elements are provided in respective proportions calculated to produce an intermetallic product with an electron concentration of 1.5, as determined by the Hume-Rothery method" |
| "respective proportions"<br>(Claim 1, 28) | Plain and ordinary meaning |
| "the two metal elements are provided in respective proportions calculated to give an electron concentration of 1.5, thereby forming intermetallic compound NiAl"<br>(Claim 28) | "at least two metal elements are provided in respective proportions calculated to produce an intermetallic product with an electron concentration of 1.5, as determined by the Hume-Rothery method, thereby forming intermetallic compound NiAl." |
| "at least one further inert metal, wherein the at least one further inert metal is not capable of an exothermic reaction with the at least two metal elements upon activation of the shaped charge liner"<br>(Claim 1) | "at least one further inert metal, wherein the at least one further inert metal is not capable of an exothermic reaction with any of the at least two metal elements upon activation of the shaped charge liner." |
| "at least one further inert metal is not capable of an exothermic reaction with the two metal elements upon activation of the shaped charge line"<br>(Claim 28) | "at least one further inert metal is not capable of an exothermic reaction with any of the two metal elements upon activation of the shaped charge liner." |

### 2.5 Prior Art

16. It is my understanding that prior art may include items that were publicly known or used or offered for sale, publications, or patents that disclose the claimed invention or elements of the claimed invention. To be prior art, the item or reference must have been made, known, used, published, or patented either before the invention was made or more than one year before the filing date of the patent application.

17. I understand that a patentee can antedate or "swear behind" a reference by establishing a priority date of the invention before the effective date of the reference. It is my understanding that the priority date of an invention embodied within a patent is determined from the date of reduction to practice or the date of conception coupled with reasonable diligence in reducing the invention to practice. I understand that conception is the formation in the mind of the inventor, of a definite and permanent idea of the complete and operative invention, as it is to be applied in practice. I further understand that reduction to practice occurs either as of the filing of the patent application or when the invention was actually made and was shown to work for its intended purpose. It is my understanding that reasonable diligence means that the inventor worked continuously on reducing the invention to practice, without significant interruption and accomplished in a reasonably prompt manner, considered in light of all the surrounding circumstances.

18. In this rebuttal expert report, I may use the phrase "prior art." However, my use of this phrase should not be interpreted as a concession by me that the item(s) described qualify as

prior art under the patent laws.[2] I merely use this phrase to address the items labeled as "prior art" in Dr. Brooks' report.

### 2.6 Anticipation

19. It is my further understanding that a patent claim may be invalid if the accused infringer proves by clear and convincing evidence that the claim is anticipated. To prove anticipation, I understand that the accused infringer must show that all of the requirements of that claim were disclosed, either expressly or inherently, in a single prior art printed publication or patent. I also understand that inherent anticipation requires proof that the missing descriptive material is necessarily present, not merely probably or possibly present, in the prior art.

20. I also understand that for a reference to be anticipatory, the reference must contain an enabling disclosure. I understand that merely naming or description of the subject matter is insufficient if it cannot be produced without undue experimentation. I also understand that a reference contains an enabling disclosure if the public was in possession of the claimed invention before the invention date. Such possession is effected if one of ordinary skill in the art could have combined the publication's description of the invention with his or her knowledge to make the claimed invention.

### 2.7 Obviousness

21. In determining whether a patent is obvious in light of prior art, it is my understanding that a number of secondary considerations may be taken into account to give light to the circumstances surrounding the origin of the patented subject matter. These secondary considerations include commercial success, long felt but unsolved needs, failure of others, prior

[2] *See* 35 U.S.C. §§ 102 and 103

art teaching away from the claimed invention, industry acknowledgement, invention contrary to accepted wisdom, skepticism of experts, praise, licensing and royalty payments, copying by others, and near simultaneous invention by two or more equally talented inventors working independently. I understand that in assessing obviousness, one needs to be mindful of the distortion caused by hindsight bias and cautious of arguments reliant upon after-the-fact reasoning in the obviousness inquiry. It is also my understanding that a party seeking to invalidate a patent on the basis of obviousness must demonstrate by clear and convincing evidence that a person of ordinary skill in the art would have been motivated to combine the teachings of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so.

### 2.8 Motivation to Combine

22. Whereas traditionally motivation to combine required a teaching, suggestion, or motivation to be found explicitly or implicitly: (1) in the prior art; (2) in the knowledge of those of ordinary skill in the art; or (3) from the nature of the problem to be solved, a flexible approach is now used when determining obviousness and the motivation to combine references. The legal determination of the motivation to combine references allows recourse to logic, judgment, and common sense, but that any such motivation to combine references must still avoid the improper application of hindsight or be based on the patentee's disclosure of his invention as found in the patent specification, drawings, and claims

### 2.9 Non-Analogous Art

23. Two criteria are relevant in determining whether the prior art is analogous: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor's endeavor, whether the reference is still reasonably pertinent to the particular problem with which the inventor is involved.

### 2.10 When References Teach Away from a Combination

24. It is improper to combine references where the references teach away from their combination. A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant. The degree of teaching away will depend on the particular facts; in general, a reference will teach away if it suggests that the line of development flowing from the reference's disclosure is unlikely to be productive of the result sought by the applicant. I understand that a reference teaches away, for example, if (1) the combination would produce a seemingly inoperative device, or (2) the references leave the impression that the product would not have the property sought by the applicant or would no longer achieve the intended purpose(s) of the references being modified or combined.

### 2.11 Written Description

25. I understand that a patent must contain a written description of the subject matter claimed in the patent. To satisfy the written description requirement, I further understand that the patent must describe the invention. It is my understanding that the written description requirement is evaluated as of the date the patent was filed. I understand that this requirement is satisfied if a person of ordinary skill in the art reading the patent would recognize that the patentee actually invented what is claimed. In other words, the description must convey to a person of skill in the art that, as of the filing date of the patent, the inventor was in possession of the invention claimed.

### 2.12 Inequitable Conduct

26. I understand that to prevail on the defense of inequitable conduct, the accused infringer must prove that the applicant misrepresented or omitted material information with the

specific intent to deceive the USPTO. I understand that a party asserting an inequitable conduct defense must prove both intent and materiality by clear and convincing evidence. I understand the materiality prong generally focuses on but-for materiality, that is but-for the act or omission the USPTO would not have allowed the claim at issue. Accordingly, this requires the accused infringer to show the USPTO was actually deceived. I understand that proving specific intent requires a finding that the applicant's intent to deceive is the single most reasonable inference that can be drawn from the relevant evidence. Hence, if there are multiple reasonable inferences, the intent prong cannot be satisfied.

## 3. Overview of the Cited References

### 3.1 "Delacour"

27. U.S. Patent No. 3,235,005 ("Delacour") is a 1956 patent entitled "Shaped Explosive Charge Devices." Delacour was disclosed to the patent office by the applicant during prosecution of the '394 patent. GEOD3_000001-530. Delacour was also used by the examiner in an obviousness rejection of the pending claims. *Id*. Delacour is directed to a shaped charge explosive device that is "capable of producing increased cracking and breaking effects." *Id*. at 1:35-36. The increased cracking and breaking effects of Delacour are created by using in the liner a substance "which is adapted to produce a highly exothermic chemical reaction under the action of the explosion." *Id*. at 1:45-49. Delacour teaches that the substance or mixture of substances that create the exothermic reaction are made up of "titanium alone, or any other metal forming part of the titanium group" in order to produce an exothermic reaction. *Id*. at 2:43-49. According to Delacour, the following mixtures may also be used:

$$Ti+C$$
$$Ca+2Si$$
$$8Al+3KClO_4$$
$$3PbO_2+4Al$$

Delacour does not disclose using anything other than the above mixtures, titanium, or a titanium group metal to create the exothermic reaction, particularly not in an electron concentration of 1.5. Moreover, all the reactions disclosed by Delacour produce significant heats of reaction much greater than 300 cal/g. Delacour also fails to disclose that the liner of a shaped charge can be made out of a reactive material and a neutral material. Instead, Delacour explains that, "[a]ccording to the invention, the liner 5 is made either of a material creating an exothermic reaction or of a neutral material coated entirely or partly with a substance having these properties." *Id*. at 3:42-45.

**3.2 "Wade"**

28. Dr. Brooks relies on a 1962 paper entitled "Field Tests Indicate New Perforating Devices Improve Efficiency in Casing Completion Operations" ("Wade"). The paper outlines the results from field test of new perforating technologies, including the "Reactive-Liner Shaped Charge."

29. Wade touts the self-cleaning properties of reactive charges based on laboratory flow tests. Wade also details field tests of a reactive shaped charge, noting that "[u]se of the reactive liner permitted some wells to be broken down without resorting to the acidizing operation which was normally required." Wade at 1071. However, the secondary reaction disclosed by Wade "is formed by the use of a titanium liner in the basic charge." Wade does not disclose an exothermic reaction caused by intermetallics, particularly not in an electron concentration of 1.5. And Wade

does not disclose a liner material made up of reactive metals and further inert metals formed as a green compacted particulate composition.

**3.3 "Liu"**

30. U.S. Patent No. 7,393,423 ("Liu") is entitled "Use of Aluminum in Perforating and Stimulating a Subterranean Formation and Other Engineering Applications." Liu is assigned to GEODynamics, Inc. Liu was disclosed by the applicant during prosecution of the '394 patent. GEOD3_000001-530. In fact, the inventor of the Liu patent, Dr. Liu, wrote the examiner three letters during prosecution of the '394 patent protesting the patentability of the application and requesting that the examiner not grant a patent. *Id*. Despite being aware of the Liu reference, the examiner never cited the Liu reference in an office action. Dyna also challenged the patentability of the '394 patent over Liu in an *Inter Partes* Review. DYNA3_0000343. Dyna's petition for IPR was denied. GEOD3_005248.

31. Liu teaches "[a] chemical reaction between molten aluminum and an oxygen carrier such as water." Liu Abstract. Specifically, according to Liu, "the present invention creates a 'dual-explosion'. The first explosion is from the reaction of the explosive device, and the second being the Al-$H_2O$ reaction." *Id*. at 11:4-6. That is, Liu discloses a second exothermic reaction based on a shaped charge that projects molten aluminum into the perforation where the "molten aluminum is then forced to react with water to create an explosion locally within the perforation." *Id*. at 6:9-13; *see also id*. at 11:1-7, 14:34-40. Liu does not disclose a metal-metal intermetallic exothermic reaction.

32. Liu further explains that the "energetic Al – $H_2O$ in the small perforation releases a large amount of heat and hydrogen gas, and generates a pressure pulse." *Id*. at 26:3-5. Thus, unlike the intermetallic reaction of the '394 patent, the oxygen carrier type reaction disclosed in Liu releases hydrogen gas to generate pressure within the perforation tunnel

### 3.4 "Hardt"

33. The Hardt reference is a technical report from Lockheed Palo Alto Research Laboratory submitted to the Air Force Armament Laboratory in July 1971. The Hardt reference is entitled "Incendiary Potential of Exothermic Intermetallic Reactions." The report was approved for public release and unclassified on March 30, 1976. Hardt was disclosed by the applicant during examination.

34. Hardt is a literature review of the thermochemistry o exothermic alloy formation, measurements of reaction rates, reaction temperatures of lose and pressed powders. As explained by Hardt, "[t]he objective of [its] research was to study the incendiary potential of intermetallic reactions." DYNA3_0002652. To that end, Hardt found that "[t]he borides, carbides, and aluminides of titanium, zirconium, and nickel were found to offer the greatest promise." *Id*. Specifically, Hardt found that intermetallic reactions would "have wide applicability in improving the performance characteristics of pyrotechnic, ordnance, and incendiary devices." *Id*. The study ultimately found that intermetallic reactions are useful for "tracer munitions, as igniters for smoke cartridges and signal flares, in infrared decoys, [and] shock and temperature resistant boosters for ordnance systems." DYAN3_0002706.

### 3.5 "Battelle"

35. Battelle is a 1988 presentation entitled "New material technologies for defence engineering." Battelle is a German document that has been translated to English. I have not received an independent translation of the original German document, or an independent sworn affidavit attesting to its accuracy, and I reserve the right to challenge the accuracy of the translation.

36. Battelle discloses using materials that induce an exothermic reaction in a liner "[t]o achieve a fire effect after the penetration of the armour." DYNA3_0002735. Battelle lists NiAl

as one of four "metal-metal" reactions. DYNA3_0002736. Battelle does not list any titanium or titanium group metals. Battelle teaches that the "liners were produced by . . . layering alternate thin layers (20 to 100 um) of Al foil and Ni wire mesh one on top of another, and subjecting them to compression and heat treatment." *Id*. Battelle teaches that, in forming the liner, heat is applied such that the intermetallic compound partially forms in the liner material. DYNA3_0002754. Finally, Battelle discloses that penetration performance of the liner can be improved by combining the reactive liner "with a thin inner copper cone." DYNA3_0002736.

37. Battelle relates to reactive liners in the military context. Indeed, the purpose of using reactive metals in Battelle is to create a shaped charge that will ignite a target. To this end, Battelle tested "[t]he ability to set fuel tanks filled with gasoline or with diesel oil on fire." *Id*. As opposed to the copper liners, Battelle found that the NiAl liners set both types of fuel tanks on fire. *Id*.

**3.6 "Reese"**

38. U.S. Patent No. 7,011,027 ("Reese") purportedly relates back to a provisional application filed in 2000. Reese is entitled "Coated Metal Particles to Enhance Oil Field Shaped Charge Performance." Baker Hughes was the original assignee of Reese. Reese was used as a secondary reference in Dyna's unsuccessful IPR challenge of the '394 patent. DYNA3_0000343.

39. Reese discloses "[a] liner for a shaped charge comprising powdered heavy metal tungsten coated with a metal binder coating compressively formed into a liner body." Reese Abstract. Reese does not disclose making a liner out of metallic powders. Reese does not disclose any exothermic reaction created by the liner. More specifically, Reese discloses "[a] liner for a shaped charge comprising powdered heavy metal particles with a substantially uniform coating of metal binder coating, the coated heavy metal particles compressively formed into a liner body." *Id*. at 4:19-23. The heavy metal particles "are selected from the group

consisting of tungsten, uranium, tantalum, and molybdenum." The metal binder coating of Reese can be selected from the group consisting of "copper, lead, nickel, or other malleable metals, and alloys thereof." According to Reese, the powdered heavy metal particles "comprise from 60 percent to 97 percent by weight of the liner," with the metal binder coating material making up the reaming percentage of the liner. *Id*. at 4:29-34.

**3.7 "Fischer"**

40. "Fischer" is a 1996 paper presented at the AIAA/ASME/SAE/ASEE Joint Propulsion Conference. The Fisher paper is entitled "A Survey of Combustible Metals, Thermites, and Intermetallics for Pyrotechnic Applications." Fischer is cited on the face of the '394 patent. Fischer was also used as a secondary reference in Dyna's unsuccessful IPR challenge of the '394 patent. DYNA3_0000343.

41. Fischer provides a list of many thermite and intermetallic compounds, as well as metal fuels for "pyrotechnic applications." DYNA3_0000673. Fischer explains that "[a]pplications for intermetallic reactions include: . . . shape-charge liners." *Id*. However, Fischer does not disclose the use of intermetallic liners in the oil and gas industry. Other than this brief summary of potential uses, Fischer simply lists 153 intermetallic reactions. Among the 153 intermetallic reactions disclosed, Fischer lists Al + Ni, Al + Li, and Al + Pd.

**3.8 "Theis"**

42. "Theis" is a 1982 French patent application entitled "Use of a Composite Material Having Two Metal Components That Are Made to Undergo a Highly Exothermic Reaction Induced by a Shock Wave, Intended for a Part of a Projectile." I have been provided with a translation of Theis. However, I reserve the right to challenge the accuracy of the translation should such information be made available to me. Theis was used as a secondary reference by Dyna in its unsuccessful IPR challenge of the '394 patent. DYNA3_0000343.

43. The application for the Theis application was Rheinmetall GMBH. Rheinmetall is a German defense company that manufactures, among other defense items, weapons and ammunition. It does not appear that Rheinmetall ever produced a product that embodied the disclosures of the Theis application.

44. Theis "relates to the use of a composite material comprising two metal components that can be made to undergo a highly exothermic reaction induced by a shock wave, and intended for a part of a projectile, and in particular the nose thereof, the projective preferably being intended for ammunition for automatic barrel weapons." DYNA3_0000302 at 1-7. The goal of Theis is to "exert an incendiary effect after penetrating the armor." *Id*. at 12-13. In Theis, the exothermic reaction between the two metal components is initiated by the projectile with the metals on its nose impacting a target. Theis disclose three metal components that can be used to create the exothermic reaction: Pd-Al, Ni-Al, and Pt-Al.

**3.9 "Bourne"**

45. WO 03/042625 ("Bourne") is a published PCT application from 2003 entitled "Shaped Charge Liner." The Application for Bourne is QinetiQ, the company that was the original assignee of the '394 patent. Bourne was considered by the examiner during prosecution of the '394 patent. GEOD3_000001-530. Specifically, Bourne was used as a secondary reference in a §103 rejection that was ultimately traversed by the application during prosecution of the '394 patent. Bourne was also used as a secondary reference by Dyna in its unsuccessful IPR challenge to the '394 patent. DYNA3_0000343.

46. Bourne discloses "a liner for a shaped charge having a composition comprising greater than 90% by weight of powdered tungsten and up to 10% by weight of powdered binder." DYNA3_0000416. Bourne is particularly concerned with the grain size of the powdered

tungsten. Bourne does not disclose the use of intermetallic powders in the liner, and does not disclose a liner capable of forming an exothermic reaction.

### 3.10 "Becker"

47. WO 01/77607 ("Becker") is a published PCT application from 2001 entitled "Projective for the Destruction of Large Explosive Targets." DYNA3_0000703. Becker was prosecution by the Raytheon Company. Becker was used as a secondary reference by Dyna in its unsuccessful IPR challenge of the '394 patent. DYNA3_0000343.

48. Becker discloses "an incendiary munition projective which is particularly well adapted for use in destroying large nominally explosive targets, but which is also advantageously usable for other ordinance applications." DYNA3_0000704. That is, the goal of Becker is to deliver "a high temperature (2000°C or more) payload at long standoffs to accomplish the destruction via deflagration or detonation at a safe distance." DYNA3_0000706 at 17-20. The targets contemplated by Becker include "Mines, torpedo warheads or unexploded bombs." *Id*. at 20-21. And the incendiary munition is activated by using "launch propellant to initiate tracer material which, in turn, ignites the payload post launch." *Id*. at 23-25. Becker does not disclose a reactive liner. Rather, in Bell, the pyrogenically activated intermetallic reactive payload is placed inside a hollow nose of the projectile. Becker discloses that the preferred material for the payload is either titanium and boron or nickel and aluminum. DYNA3_0000707 at 9-11.

## 4. The Asserted Claims Are Not Obvious

### 4.1 Delacour in view of Hardt, Battelle, and/or Reese Does Not Render the Asserted Claims Obvious

49. It is my opinion that Delacour in view of Hardt and/or Battelle and/or Reese does not render obvious any of the asserted claims of the '394 patent. As an initial matter, Delacour does not disclose a green compacted particulate, which the Court has construed to mean "a pressed

powder that has not been further strengthened as by sintering." Delacour has no discussion about how the "substance of mixture of substances" are created or shaped into the liner.

50. Delacour also does not disclose the limitation of the '394 patent requiring that "the at least two metal elements are provided in respective proportions calculated to give an electron concentration of 1.5." *See* Ex. C to Brooks' Report. And Delacour does not disclose the limitation that "the composition further comprises at least one further inert metal" that is "not capable of an exothermic reaction with the at least two metal elements upon activation of the shaped charge liner." The Court construed this limitation to mean "at least one further inert metal, wherein the at least one further inert metal is not capable of an exothermic reaction with any of the at least two metal elements upon activation of the shaped charge liner." Rather, Delacour only discloses that the liner is made of "copper or any other 'neutral' substance" and that the liner has a "coating 6 on its outer surface of a substance capable of creating an exothermic reaction." Delacour does not disclose, as required by the claims, that the liner contains both the reactive elements and "one further inert metal" all in a particulate powder mixture.

51. In order to teach these missing limitations, Dr. Brooks relies on combinations with three additional references. However, I disagree with Dr. Brooks' opinion that a person of skill in the art would have been motivated to combine the teachings of Delacour with Hardt, Battelle, and/or Reese. Brooks Report at ¶ 50. Rather, a person of skill in the art would not be motivated to combine the reactive oil and gas perforator liner technology in Delacour with the military use of intermetallics for incendiaries disclosed in either Hardt or Battelle further with an oil and gas perforating liner made out of a pressed powder including tungsten as disclosed in Reese.

52. As explained in section 3.1, Delacour discloses an oil and gas shaped charge liner that is made of "titanium alone, or any other metal forming part of the titanium group." Delacour at 2:43-49. Delacour also discloses that the liner can be made of a few additional mixtures, none of which are nickel and aluminum and none of which produce an electron concentration of 1.5, as required by the independent claims of the '394 patent. To reach these missing elements of Delacour, Dr. Brooks claims that a person of skill in the art would have been motivated to combine Delacour with two references related to military applications: Hardt and Battelle. I disagree.

53. A person of skill in the art would not be motivated to combine Delacour with the military references of Hardt and Battelle because the objectives of Delacour are very different from the objectives of Hardt and Battelle. Hardt is a study of to determine the ***incendiary*** potential of intermetallic reactions. Hardt at Abstract. Battelle discuses using metal-metal reactions for the purpose of achieving "a fire effect after the penetration of the armour." Battelle at 10. For example, penetrating a fuel tank and igniting the fuel. It is my opinion that a person of skill in the art would not be motivated to combine studies relating to the burning effects of intermetallic reactions to solve Delacour's stated problem of creating cracking or breaking effects in concrete and rock.

54. Indeed, a person of skill in the art would not be motivated to look to military art at all when solving problems related to oil and gas shaped charges. I have reviewed Dr. Behrmann's declaration in connection with the unsuccessful IPR of U.S. Patent No. 8,220,394. GEOD3_001052. I agree with Dr. Behrmann's statements regarding the use of military shaped charge technology in the oil and gas industry. Similar to Dr. Behrman, the only instance I am aware of in which military shaped charge technology was used in the oil and gas perforating

industry was the incorporation of copper liners in shaped charge perforators shortly after World War II. I agree with Dr. Behrmann that this is because military shaped charges have very different requirements than shaped charges used in the oil and gas industry.

55. I have spoken with John Hardesty and have reviewed his validity report. I also agree with Mr. Hardesty in that the difference in reactive charges from the military industry are so great that oil and gas shaped charge designers have not looked to military technology; at least not before GEODynamics developed the CONNEX charge in collaboration with QinetiQ. Specifically, I agree with Mr. Hardesty that shaped charges for the military are only concerned with penetrating one boundary (armor) and are designed to do damage once that armor is penetrated. I also agree with Mr. Hardesty that military shaped charges have other criteria that make them unsuitable for oil and gas use, such as the fact that military charges must be designed to withstand extreme conditions such as high impulse and acceleration forces a long shelf life. I also understand from Mr. Hardesty and Mr. Clark that military shaped charges are not typically made of green compacted materials, for the durability reasons explained above. Based on the differences between military and oil and gas technology, it is my opinion that a person of skill in the art would not be motivated to combine military art with the oil and gas art, and even if one did, it is my opinion that a person of skill in the art would not arrive at the invention of the ’394 patent.

56. My opinion is further confirmed by a Halliburton SPE paper from 2008, which Dyna’s marketing material favorably cites. *See* DYNA_006887. The paper explains:

The use of reactive charges in the military environment involves kilograms of explosives with high-precision engineered liners containing 'reactive metals' added to enhance blast effect at the chosen targets. Manufacturing of such warheads and munitions is recognized as being highly dependent on small manufacturing tolerances and problems working at this size are well documented in the public domain (Daniels et al., 2003). When adapted to oilfield charges, which only use grams of explosives, these manufacturing tolerances are more difficult to achieve and the difficulties inherent in working with these materials are enhanced.

The use of military reactive-warhead technology involves delivering the reactive materials contained in the liner to the target destination, passing through only one boundary or interface. However, in the wellbore, where there are multiple targets with highly contrasting physical properties, i.e., the gun scallop, fluid gap, casing, cement, and rock saturated with gas, water, oil, or a combination of the three, we make assumptions that the reactive components can be delivered through all of these barriers or interfaces to effect a secondary reaction in the formation.

DYNA_004555. As outlined below in Section 4.9, other Halliburton and Schlumberger papers and presentations discourage using reactive shaped charges for oil and gas well perforation, and therefore teach away from using that technology.

57. There are even more reasons why a person of skill in the art would not be motivated to combine Delacour in the way Dr. Brooks suggests. Hardt, for example, simply mentions in passing on page 48 that one of the future applications of intermetallic reaction may be shaped charges. The thrust of Hardt is a general study of the incendiary potential of exothermic reactions. Dr. Brooks believes that a person of skill in the art would somehow zero in on the military exothermic reactions subject disclosed in Hardt to use in the Delacour shaped charge. This, however, strains credulity. It is only with pure hindsight that Dr. Brook makes the combination of Delacour with a reference that has almost nothing to do with actual shaped charge design. Indeed, other than a passing reference to the word "shaped charge," Hardt does not teach a person of skill in the art how intermetallic reactive technology could be implemented into a shaped charge.

58. I also disagree with Dr. Brooks that "[a] person of skill in the art, in possession of Hardt and Battelle, would naturally consider the nickel-aluminum reactive composition for use as a reactive shaped charge perforator." Brooks Report at ¶ 51. Delacour explains that "[t]he chemical reaction may result from the interaction between the ingredients of the substance or mixture of substances, or it may involve said ingredients and the products of the explosion or

even the components of the target." Delacour at 1:49-52. Delacour further discloses that the liner may be made out of titanium or any metal forming the titanium group. And the claims of Delacour only claim a reactive composition made out of a single metal. In fact, other than a passing reference to "mixture of substances," there is no explicit mention of a metal-metal reaction in Delacour. Rather, Delacour discloses four mixtures:

$$Ti+C$$
$$Ca+2Si$$
$$8Al+3KClO_4$$
$$3PbO_2+4Al$$

59. Of those four mixtures, none are a reactions between to metal elements as required by the claims of the '394 patent. The '394 patent itself makes it very clear that exothermic reactions can be created by combining two metal elements or by combining metal elements with non-metals:

> typically in the form of heat. The exothermic reaction of the liner can be achieved by using a typically stoichiometric (molar) mixture of at least two metals which are capable upon activation of the shaped charge liner to produce an intermetallic product and heat. Typically the reaction will involve only two metals, however intermetallic reactions involving more than two metals are known. Alternatively, the liner composition may comprise at least one metal and at least one non-metal, where the non-metal may be selected from a metal oxide, such as copper oxide, molybdenum oxide or nickel oxide or any non-metal from Group III or Group IV, such as silicon, boron or carbon. Pyrotechnic formulations involving

'394 patent at 3:66-4:10.

60. The claims of the '394 patent explicitly claim a reaction between two metal elements—not a reaction between metals and non-metals. Delacour only discloses a reaction between metals and non-metals or a reaction caused by a single metal with the exception of the

non-enabling statement, "or a mixture of such metals." A person of skill in the art would therefore not be motivated to replace the disclosed metal and non-metal reactions (or the metal only reaction) of Delacour with a metal-metal reaction as required by the claims of the '394 patent. If anything, a person of skill in the art would look to similar reactions to substitute with the ones disclosed in Delacour. Such reactions would include pure metal reactions, metal-carbide reactions, metal-silicate reactions, and thermite reactions. In fact, with reference to Hardt, many of these reactions are disclosed such that a person of skill in the art would naturally consider other carbide, silicate, and thermite reactions as opposed to metal-metal reactions. In short, a person of skill in the art would not be motivated to change the mechanism by which Delacour produces an exothermic reaction by substituting metal-metal reactions of Hardt or Battelle into Delacour.

61. Assuming that a person of skill in the art would even look to Hardt and Battelle for solving the problem in Delacour, nickel and aluminum would not be a viable candidate. This is because many mixtures disclosed in Delacour produce a much higher energy release than a nickel and aluminum reaction. For example, Delacour discloses Ti + C, which has a heat of reaction of 737 cal/g. Hardt at 8. Delacour also discloses pure titanium, which releases 4714 cal/g, and other titanium group metals (Hf = 1491 cal/g, Zr = 2135 cal/g, Th = 1265 cal/g). Fischer at 5-13. That Delacour uses high energy reactions makes sense. Delacour's primary purpose is to crack and break the formation. The nickel aluminum reaction, on the other hand, releases only 329 cal/g. Thus, a person of skill in the art would not be motivated to substitute the less energetic nickel aluminum reaction in place of the reactions already disclosed in Delacour to achieve the stated purpose of Delacour.

62. Similarly, a person of skill in the art would not be motivated to combine Delacour with Reese, and a person of skill in the art would certainly not be motivated to combine Delacour with Reese and Hardt and/or Battelle. As noted above, Delacour does not disclose the green compacted particulate limitation and the further inert metal limitation of the ’394 patent. Hardt does not teach how to incorporate exothermic materials into shaped charges at all. Hardt simply details the study of exothermic reactions for military application. A person of skill in the art would not be motivated to combine Hardt with either Reese (oil field traditional shaped charge) or Delacour (oil field titanium crack jet charge).

63. Moreover, a person of skill in the art would not be motivated to combine Delacour, Hardt, Battelle, and/or Reese to arrive at the green compacted particulate limitation of the ’394 patent. Specifically, Battelle teaches that the reactive liner is produced “by layering alternate thin layers (20 to 100 um) of Al foil and Ni wire mesh one on top of another, and subjecting them to compression and heat.” Battelle at 11. Delacour is silent as to how the liner is created. Even if a person of skill in the art were motivated to combine Delacour and Battelle, the combination would not teach the green compacted material limitation of the ’394 patent. Moreover, Battelle’s teachings are incompatible with Reese. Reese discloses making a liner with tungsten and no reactive material from a pressed powder metal. A person of skill in the art would not look to Reese’s pressed powder metal disclosure and combine it with Battelle’s heat treated layering exothermic liner to somehow arrive at a green compacted material with two reactive metal elements and a further inert metal as claimed by the ’394 patent. This conclusion is further supported by the fact that Delacour discloses keeping the liner with a “neutral” substance and the reactive material separate—i.e., not part of the same green compacted particulate. Thus, a person of skill in the art could not arrive at the ’394 patent based on the combinations of

Delacour, Hardt, Battelle, and/or Reese. Dr. Brooks' opinion otherwise is again based entirely on impressible hindsight. Not only would a person of skill in the art not combine the references, but even if one did, they could not arrive at the limitations of the '394 patent.

64. Notwithstanding all of the above reasons, a person of skill in the art would not be motivated to combine Delacour with any of the references because Delacour relates to a product, "Crack Jet," that is known in the field to be an unsuccessful product. Specifically, Schlumberger used the titanium liner reactive metal charge concept discussed in Delacour (and in Wade) for use in carbonate formations and fracturing stimulation. I have reviewed Dr. Behrmann's declaration from the '394 IPR. I agree with Dr. Behrmann that the "Crack Jet" product never garnered success, and indeed was discontinued fairly early on. As can be seen from Wade, discussed in more detail below, the Delacour charge liner failed to produce sufficiently deep penetrations due to the low liner density. And indeed, one of the problems in the prior art solved by the invention of the '394 patent is that "material which are typically used in reactive liners may have significantly reduced penetrative depth due to their physical properties." '394 patent at 2:41-43.

65. Moreover, Dr. Brooks opines that Hardt specifically teaches that nickel-aluminum combinations are effective as a pressed powder mixture of reactive metals, and cites to Hardt's abstract and Figure 21. Brooks Report at ¶ 57. But that is not how a person of skill in the art would interpret Hardt. Instead, Hardt says that: "The data were compared with those obtained by a computerized heat transfer analysis of rod shaped and hollow cylindrical geometries."

66. Thus, a person of skill in the art—who would know or find the history of the Crack Jet and would understand what is disclosed in Delacour—would not look to Delacour as a viable teaching of how to create a charge like the one disclosed in the '394 patent, nor would a person

of skill seek to improve upon Delacour. And certainly a person of skill in the art would not attempt to improve upon the problems with Delacour with the teaching from Hardt, Battelle, and/or Reese, as explained above.

67. Further undermining Dr. Brooks' opinion that the invention of the '394 patent is obvious is the fact that there has been a long felt need for reactive shaped charges yet an effective and commercially successful charge did not appear until GEODynamics released its CONNEX charge. Indeed, as Dr. Brooks points out, the fundamental principles of nickel and aluminum intermetallic reactions (and Hume-Rothery principles) have been known for some time. Yet the fact that this long felt need was not satisfied until the invention of the '394 patent shows that the link between the fundamental characteristics of intermetallic reactions (especially as disclosed in the military context) and shaped charge design was not obvious to a person of skill in the art.

68. Assuming that a person of skill in the art would even be motivated to combine the Delacour, Hardt, Battelle, and/or Reese references, no person of skill in the art would be able to make and use the invention of the '394 patent without undue experimentation. I have spoken with Mr. Hardesty and Mr. Clark, both of whom have been involved in reactive liner development for much of their careers. I agree with them that development of reactive liner technology requites much trial and error using expensive and technical testing schemes, such as API RP 19B Section II testing. Based on the disclosures in Delacour, Hardt, Battelle, and/or Reese, and neglecting the fact that only in hindsight would a person of skill in the art seek to combine the references, even with that improper hindsight it would take hundreds if not thousands of hours to test the different combinations and to perfect the liner technology to come up with the invention of the '394 patent. This undue experimentation that is required is further

exacerbated by the fact that the combination of references relied upon by Dr. Brooks does not teach or explain how the various disclosures from different fields of endeavor could be combined into the invention of the ’394 patent.

69. In short, a person of skill in the art would not be motivated to combine Delacour in view of Hardt, Battelle, and/or Reese. And even if a person of skill in the art did combine Delacour in view of Hardt, Battelle, and/or Reese, the combination still fails to disclose all of the limitations of the claims of the ’394 patent. For the foregoing reasons, the combination of Delacour in view of Hardt, Battelle, and/or Reese, would not render obvious the invention of the ’394 patent.

### 4.2 Delacour in view of Fischer, Theis, and/or Bourne Does Not Render the Asserted Claims Obvious

70. The combination of Delacour in view of Fischer, Theis, and/or Bourne fails to render obvious the claims of the ’394 patent for exactly the same reasons as the combination of Delacour in view of Hardt, Battelle, and or Reese fails, as explained in Section 4.1 above. Just like Hardt and Battelle, the Fischer and Theis references are military (or at least non-oil and gas) references that, according to Dr. Brooks, disclose a reactive liner shaped charge comprising nickel and aluminum. And Bourne, just like Reese, is simply a reference that discloses a traditional oil and gas shaped charge perforator with a liner made out of powdered tungsten and no reactive components.

71. A person of skill in the art would not be motivated to combine Delacour and Fischer. Fischer was presented in a conference relating to propulsions, and specifically relates to uses for pyrotechnical applications. As explained above, Delacour does not disclose using the titanium liner material for its pyrotechnic properties but instead is interested in the additional pressure and

energy that can be used to crack and break up the formation. A person of skill in the art would thus not look to Fischer's disclosures in an effort to improve upon the teachings of Delacour.

72. It is also important to point out that Delacour does even teach the same type of reaction as the '394 patent claims. Delacour explains that "[t]he chemical reaction may result from the interaction between the ingredients of the substance or mixture of substances, or it may involve said ingredients and the products of the explosion or even the components of the target." Delacour at 1:49-52. Delacour further discloses that the liner may be made out of titanium or any metal forming the titanium group. And the claims of Delacour only claim a reactive composition made out of a single metal. In fact, though Delacour discloses some reactions that might be considered intermetallic, there is no explicit mention of intermetallic reactions as disclosed by the '394 patent in Delacour. Rather, Delacour discloses four mixtures:

$$Ti+C$$
$$Ca+2Si$$
$$8Al+3KClO_4$$
$$3PbO_2+4Al$$

73. Of those four mixtures, none are a reactions between to metal elements as required by the claims of the '394 patent. The '394 patent itself makes it very clear, as used in the patent, silicon and carbon are not considered metals:

typically in the form of heat. The exothermic reaction of the liner can be achieved by using a typically stoichiometric (molar) mixture of at least two metals which are capable upon activation of the shaped charge liner to produce an intermetallic product and heat. Typically the reaction will involve only two metals, however intermetallic reactions involving more than two metals are known. Alternatively, the liner composition may comprise at least one metal and at least one non-metal, where the non-metal may be selected from a metal oxide, such as copper oxide, molybdenum oxide or nickel oxide or any non-metal from Group III or Group IV, such as silicon, boron or carbon. Pyrotechnic formulations involving

'394 patent at 3:66-4:10.

74. The claims of the '394 patent explicitly claim a reaction between two metal elements—not a reaction between metals and non-metals. Delacour only provides an enabling disclosure of a reaction between metals and non-metals or a reaction caused by a single metal. A person of skill in the art would therefore not be motivated to replace the metal and non-metal reactions (or the metal only reaction) of Delacour with a metal-metal reaction as required by the claims of the '394 patent. If anything, if presented with Fischer, a person of skill in the art would look to the carbide, silicate, thermite, and metal combustion reactions listed as one of the hundreds of exothermic reactions. A person of skill in the art that does not have the benefit of hindsight would not focus on the metal-metal reactions, and would certainly not seek to replace the Delacour materials with a Hume-Rothery 3/2 compound such as nickel and aluminum as described in the '394 patent. Indeed, Fischer discloses over 150 different reactions. It is a true sign of the pure hindsight employed by Dr. Brooks that the NiAl reaction is somehow obvious as compared to the laundry list of other reactions.

75. In any event, Delacour only discloses a broad genus of exothermic reactions involving at least one metal. This disclosure does not anticipate or render obvious in any way a

species of bimetallic intermetallic compounds with a ratio of valence electrons to atoms of 1.5. And as explained above, Delacour does not disclose a line composition containing these elements in a green compacted particulate with a further inert metal.

76. In short, the combination between Delacour and Fischer fails for the exact same reasons the combination between Delacour and Hardt fails. I hereby incorporate my analysis in Section 4.1 into this section and intend to provide the same reasons outlined in that section to address this combination.

77. A person of skill in the art would not be motivated to combine Delacour with Theis. As an initial matter, and as the PTAB held when denying institution of IPR on the '394 patent, "the purported similarity of the problems address in Liu and Theis does not suggest the transfer of military projective technology to the oilfield context." GEOD3_005248 at 22. The objective of Liu, just like Delacour, is to "make a shaped charge that can have a liner made of energetic material." Brooks Report at ¶ 95 (citing Liu at 6:16-17). Thus, the patent office has already found that a person of skill in the art would not be motivated to combine the military technology in Theis with an oilfield reference such as Delacour. I agree with the patent office that a person of skill in the art would not combine military technology with oilfield technology. *See* Section 4.1. Indeed, the entire stated purpose of Theis is to provide a penetrative effect of a projective with an incendiary effect. Theis at 2:20-23. And Theis makes no mention of a shaped charge; the entire disclosure instead relating to a high speed projectile.

78. Moreover, as explained above, a person of skill in the art would not look to the metal-metal reactive technology in Theis as a replacement for the metal-nonmetal or pure metal reactive materials in Delacour. The mechanism by which the reaction in Theis occurs is also very

different from Delacour. Theis discloses putting a reactive liner at the nose of a projectile such that when the projectile strikes a target, the reaction will occur.

79. Even if a person of skill were motivated to combine the references, neither Theis nor Fischer discloses how a reactive liner could be made. Thus, even with the combination, the claim limitation that the two metal elements are provided in a green compacted particulate is not disclosed and a person of skill in the art would not be able to practice that element—even with undue experimentation.

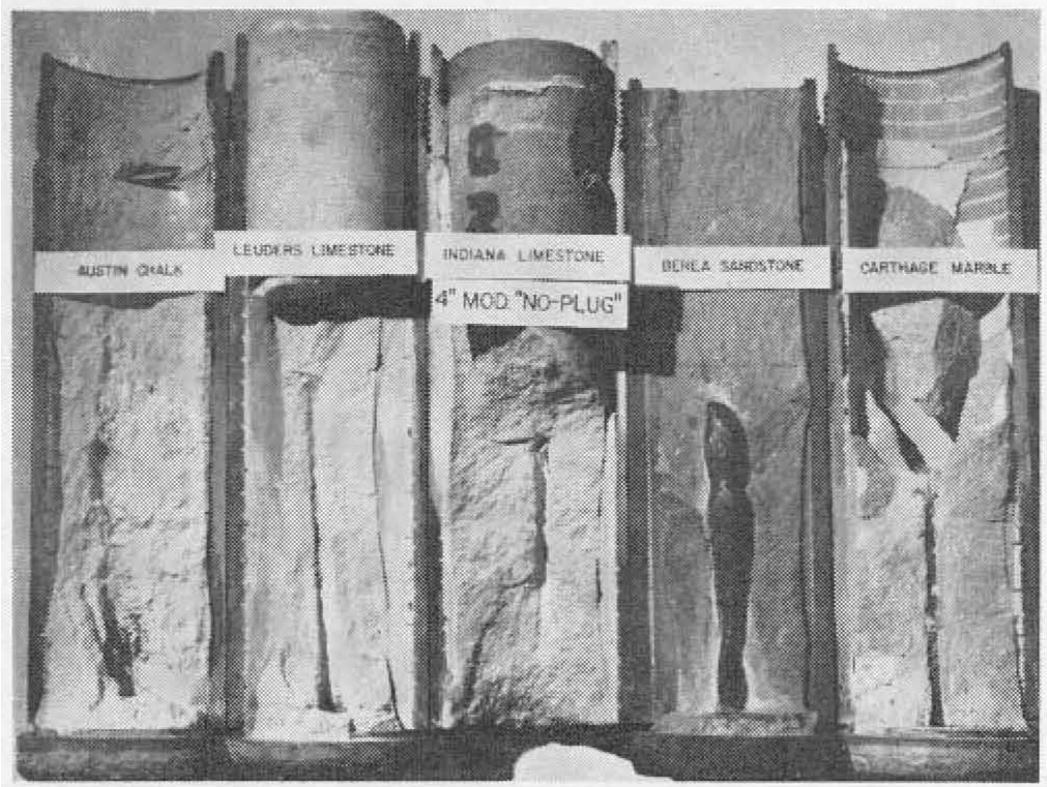
80. Bourne only discloses a green compacted liner with tungsten and some additional soft metallic and non-metallic binders. Bourne does not teach or even suggest a reactive liner. For the same reasons states in Section 4.1 with respect to Reese, a person of skill in the art would not be motivated to combine Bourne with Delacour, Fischer, and/or Theis.

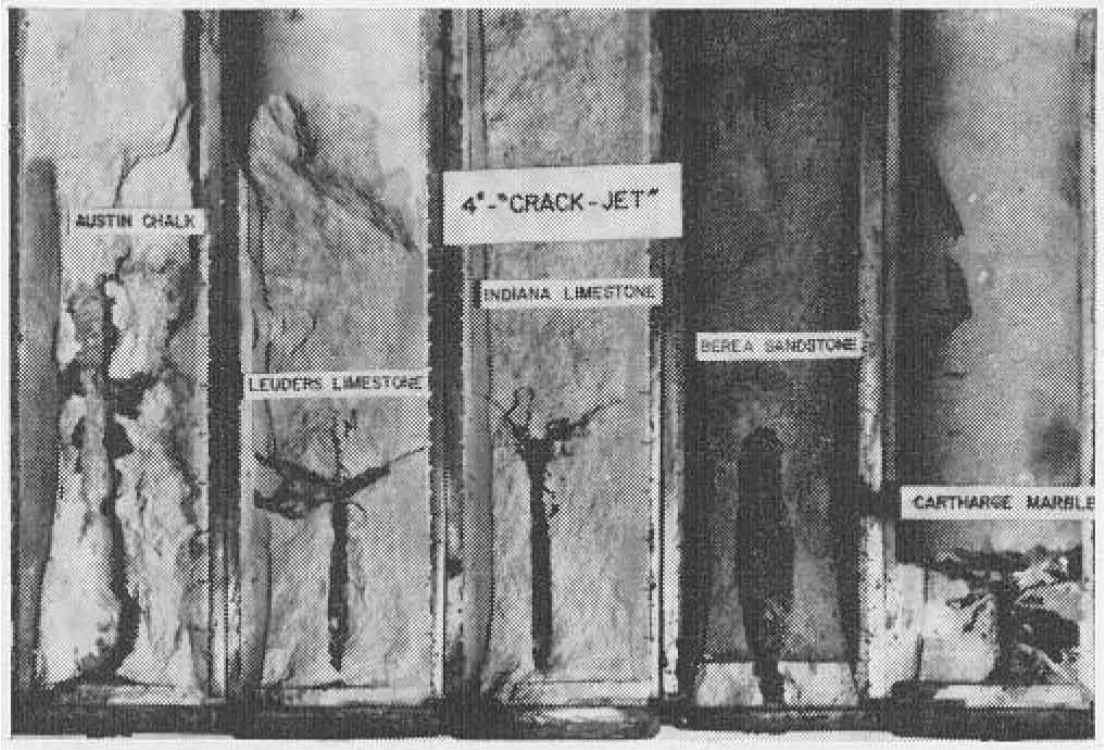
81. Finally, even if a person of skill in the art combined all of the references, the combination still fails to disclose all of the limitations of claims 1 and 28 of the ’394 patent. The combination does not disclose a green compacted particulate composition formed from a powder mixture comprising at least two metal element and a further inert metal. And a person of skill in the art would not be able to reach this limitation based on the disclosures—especially considering that neither Fischer nor Theis explains how a reactive composition of two metal elements that will give an electron concentration of 1.5 could be made, let alone a composition containing both those metal elements and a further inert metal. Delacour, in addition, teaches away from combining all three into a single green compacted particulate liner, as Delacour discloses a “neutral” material (which is not an inert material, as explained in Section 4.1) being in a liner separate from the titanium or other disclosed exothermic composition.

82. Therefore, for the foregoing reasons, and the additional reasons explained with respect to the Delacour, Hardt, Battelle, and/or Reese combination in Section 4.1, the combination of Delacour in view of Fischer, Theis, and/or Bourne does not render obvious any asserted claims of the '394 patent.

### 4.3 Wade in view of Hardt, Battelle, and/or Reese Does Not Render the Asserted Claims Obvious

83. Wade discloses nothing more (and, in fact, less) than Delacour. Wade is simply "supplemental reporting on laboratory and field results in support of the reactive charges described in Delacour." Brooks Report at ¶ 79. Dr. Brooks opines that "[t]he advantageous results of Wade would encourage a person of skill in the art to consider whether improvements could be made to the underlying charge, namely the reactive Crack-Jet charge described in Delacour." *Id*. at ¶ 83. But a person of ordinary skill in the art would know that the Schlumberger Crack-Jet charge delivered poor penetration due to the material's low density and was shortly discontinued. GEOD_02531. Moreover, a person of skill in the art would look to Wade and see the poor performance on the face of the reference. From Figure 4 (conventional charges) and Figure 5 (reactive charges), reproduced below, the poor penetration of the charges is apparent.


AUSTIN CHALK
LEUDERS LIMESTONE
INDIANA LIMESTONE
4" MOD "NO-PLUG"
BEREA SANDSTONE
CARTHAGE MARBLE


AUSTIN CHALK
4"-"CRACK-JET"
INDIANA LIMESTONE
LEUDERS LIMESTONE
BEREA SANDSTONE
CARTHAGE MARBLE

84. Further, Wade only discloses that the secondary reaction is caused by a titanium liner. And Wade gives no information about how the liner is formed or integrated into the shaped charge. A person of skill in the art would have no motivation to combine this disclosure with non-oilfield references that relate to metal-metal powder intermetallic reactions to form a compound with an electron concentration of 1.5 as determined by Hume-Rothery. Indeed, there is even less of a motivation to combine Wade with Hardt, Battelle, and/or Theis than there is to combine Delacour with those references. Therefore, for the above reasons and for the additional reasons states in Section 4.1, Wade in view of Hardt, Battelle, and/or Reese does not render obvious any asserted claim of the '394 patent.

### 4.4 Wade in view of Fischer, Theis, and/or Bourne Does Not Render the Asserted Claims Obvious

85. I disagree with Dr. Brooks that a person of skill in the art would be motivated to combine the teachings of Wade with Fischer, Theis, and/or Bourne. Moreover, the combination of Wade with Fischer, Theis, and/or Battelle does not disclose each and every limitation of the claims of the '394 patent. Rather, for the reasons stated above in Sections 4.2 and 4.3, it is my opinion that Wade in view of Fischer, Theis, and/or Bourne does not render obvious any asserted claim of the '394 patent.

### 4.5 Liu in view of Fischer and Hardt Does Not Render the Asserted Claims Obvious

86. A person of skill in the art would not be motivated to combine Liu with Fischer and Hardt. This is not only my opinion, but the opinion of the Patent Trial and Appeals Board. Dyna filed an IPR on the '394 patent. The IPR did not institute. The Board found that Liu disclosed a very different chemical reaction, based on a very different mechanism, from the disclosures in Fischer. Based on this, the Board found that Dyna did not even have a reasonable likelihood of prevailing on the ground that Liu in view of Fischer renders the '394 patent obvious. The

inclusion of Hardt does not change this calculus. As explained above, Hardt does not provide anything in addition to Fischer that would cause a person of skill in the art to combine the reference with an oil and gas reactive charge using a different chemical reaction or mechanism. In fact, one of the sources of Fischer's data table is Hardt, so there is quite literally no distinction between the disclosures in this regard.

87. The term intermetallic never appears in Liu. Specifically, Liu describes "a shaped charge that has a powdered aluminum liner . . . that produced a hot aluminum jet that penetrates the steel casing into the formation and then reacts with the wellbore water inside the perforation tunnel." Brooks Report at ¶ 102. This is a completely different reaction that the reactions disclosed in Hardt and Fischer. A person of skill in the art would not look to those references to find ways to improve on Liu. Indeed, there is no teaching or suggestion in Liu, Fischer, or Hardt that would suggest a metal-metal intermetallic reaction, such as nickel and aluminum, could serve as a replacement for the Al- $H_2O$ reaction disclosed in Liu. In fact, Liu makes a point to explain that the benefit of the reaction is both the release of heat and gas. Neither Fischer nor Hardt disclose reactions of any type with water. And the very reference cited by Dr. Brooks, Fischer, shows that the reaction between nickel and aluminum creates no gas. Fischer at 9. Thus, a person of skill in the art would never look to Fischer or Hardt (which also discloses non-gas releasing reactions) when attempting to improve upon Liu.

88. Further to the point that Liu cannot be used in a combination to render the '394 patent claims obvious, the inventor of Liu (Dr. Liquing Liu) actually wrote the examiner three times during prosecution of the '394 patent. As an initial matter, the applicant of the '394 patent listed Liu as a in an information disclosure statement on October 24, 2006. GEOD3_000388. On January 12, 2009, during prosecution of the '394 patent, Dr. Liu submitted a protest, presumably

under 37 CFR 1.291. GEOD3_000371. This rule allows a protest to be filed by a member of the public against a pending application. The protest references an earlier letter filed on December 11, 2008. That letter does not appear in the file history of the patent and may have been excluded due to failure to comply with the regulations.

89. Dr. Liu's letter of January 12, 2009 specifically called out the Liu reference and another patent that Dr. Liu believed disclosed the invention of the then pending application. Nevertheless, 9 days later on January 21, 2009, the examiner issued a non-final rejection that did not include the Liu reference. GEOD3 000331. Dr. Liu submitted another letter on that same day, January 21, again calling out the Liu reference along with other references. GEOD3_000349. On March 30, 2010, the examiner issued a non-final rejection that did not include Liu. GEOD3_000255. On April 8, 2010, the examiner issued a final rejection that did not rely on Liu. GEOD3_000251. Yet again, on June 7, 2010, the examiner issued another non-final rejection that did not rely on Liu. GEOD3_000217.

90. Despite all of this, on November 30, 2010, Dr. Liu wrote the examiner a third letter, again arguing that the '394 patent application was directed to an invalid invention.GEOD3_000190. This final letter did not persuade the examiner. On December 27, 2010, a final rejection was issued that did not include Liu. GEOD3_000168. There was one more non-final rejection on August 8, 2011 that, unsurprisingly, did not list Liu as a reference. GEOD3_000133. The application was allowed on March 12, 2012. GEOD3_000068.

91. To sum this timeline up, the applicant told the examiner about Liu, and Dr. Liu himself wrote at least three letters to the examiner during prosecution urging that the '394 application was invalid in part based on the Liu reference. Notwithstanding all of this, the examiner issued six rejections, none of which even mentioned Liu. This chain of events supports

my opinion as the examiner found Liu so irrelevant to the teachings of the '394 patent application and pending claims that the examiner did not see it fit to even include Liu in a rejection.

92. The prosecution history relating to Liu would be convincing enough, but that is not the only time the Liu reference was rejected. As noted above, the Liu reference in combination with Fischer was raised as an obvious ground in an IPR brought by Dyna. The patent office found that Liu in view of Fischer did not even present a reasonable likelihood of succeeding in establishing obviousness, and denied institution of the IPR. *See* GEOD3_005248.

93. Dr. Brooks points to a portion of Liu that mentions replacing a part of the aluminum with another metal to increase the thermal energy of the system. But Dr. Brooks leaves out the entire context. Liu actually discloses:

Numerous other variations based on the above three embodiments to produce molten aluminum in its molten state are possible, without departure from the spirit described above. Theoretically, any detonable or combustible mixture that has an exothermic reaction can be used to mix with Al in an surplus amount in stoichiometry to produce molten aluminum to react with water. Possible variations include but are not limited to:

1) The high explosive used is a mixture of two or more than two explosives, such as a mixture of RDX and TNT;
2) The combustible mixture is not limited to be a mixture of oxidizer/Al, but it can also be a propellant, a pyrotechnic mixture, etc.;
3) Aluminum powder is not directly mixed with metal oxides, but with some chemical compounds that can be decomposed into metal oxides and other materials under raised temperatures such as some carbonates, like Manganese Carbonate ($MnCO_3$).
4) In stoichiometry, a part of aluminum is replaced by other materials that can be generally classified as "fuel", such as magnesium, lithium, zirconium, silicon, boron, etc.

'394 patent at 20:29-49 (*see also* GEOD3_001094).

94. The plain reading of the language would not lead a person of skill in the art to believe that these additional "fuels" react with aluminum. Indeed, Dr. Brooks knows this, and carefully chooses his words: "Liu discloses that certain of the 'magnesium, lithium, zirconium, silicon, boron, etc.' reacts in liners ***in the presence of aluminum*** to produce 'a substantial amount of thermal energy.' Brooks Report at ¶ 106. Of course, materials that react "in the presence of aluminum" does not teach or suggest a metal that reacts with aluminum, as required by the claims of the '394 patent.

95. Moreover, the word "fuel" as used in Liu does not mean that the "magnesium, lithium" and so on are provided to react and release energy with the aluminum. Rather, as explained by the patent, the word fuel is used to describe the material that is reacting with an oxygen carrier:

> The present invention uses aluminum's reactivity in its molten form with some commonly seen oxygen-carrying chemicals like water or metal oxides. When Al is heated to above its melting point (660° C.), it reacts with water and gives off a large amount of energy. In such a reaction molten aluminum is fuel, and water functions as an oxidizer. Such a

Thus, when the Liu reference talks about replacing the aluminum with other fuels, it is describing replacing the aluminum with other materials that are designed to react ***with the water***, not with the aluminum. The plain reading of Liu therefore contradicts Dr. Brooks' statement that "[a] person of ordinary skill would naturally consider Fischer and Hardt for their teachings of metal combinations that are specifically designed to exothermically react after charge detonation." Brooks Report at ¶ 106. Dr. Brooks' reasoning for the combination completely falls apart when the proper reading of Liu is revealed as neither teaching nor suggesting a metal combination designed to react exothermically.

96. In short, Dr. Brooks' opinion is rather based on Hindsight—the combination of the intermetallic reactions in Fischer and Hard only make sense to include in Liu once the disclosure of the '394 patent is understood. Liu has nothing to do with an exothermic reaction between two metal elements to form an intermetallic compound with an electron concentration of 1.5. A person of skill in the art would therefore not be motivated to look at references such as Fischer and Hardt that disclose metal-metal reactions as defined by the 394 patent. Moreover, as explained in Sections 4.1 through 4.4, a person of skill in the art would not be motivated to combine oilfield references such as Liu with military references such as Fischer and Hardt.

97. The PTAB's reason for denying institution of the IPR is still applicable here:

> "[Dyna] does not provide adequate technical reasoning to explain why a person of ordinary skill in the art would have employed an intermetallic alloying reaction (taught in Fischer) in place of Liu's disclosed reaction between aluminum—or such other material that Liu identifies as "fuel" []—and water. Nor does [Dyna] adequately explain why a person of ordinary skill would have combined Liu with Fischer, such that the resulting combination employed the distinctly different physical operation involved in claim 1 of the '394 patent—wherein the liner includes both reactants—as opposed to the identified embodiments of Liu, in which the liner material is brought together with an external, ambient reactant (i.e., water), as consequence of the detonation. In addition, whereas Liu discusses the significant of the reaction of liner material with water that produced hydrogen gas [], Fischer shows that the intermetallic reactions that [Dyna] discusses [] produce no hydrogen and no gaseous products at all []. Accordingly, in a situation such as the present one, '[w]ithout any explanation as to how or why the references would be combined to arrive at the claimed invention, we are left with only hindsight bias that *KSR* warns against.'"

GEOD3_005248 at 18-19.

98. As noted, Hardt discloses nothing in addition to the disclosure of Fischer that would change the PTAB's reasoning. And Dr. Brooks provides no additional explanations that would alter the PTAB's ultimate conclusion. Based on my independent analysis of all of the facts and evidence, I agree with the PTAB. It is my opinion that the combination of Liu in view of Fischer and Hardt does not render obvious any asserted claim of the '394 patent.

### 4.6 Liu in view of Theis Does Not Render the Asserted Claims Obvious

99. For all of the reasons stated above in Section 4.5, a person of skill in the art would not be motivated to combine Liu with Theis. The combination of Liu and Theis was used as an obviousness ground by Dyna in the IPR of the ’394 patent. DYNA3_0000343. The ground was rejected and the IPR petition denied. GEOD3_005248. In addition, the reasons stated in Section 4.2 and 4.4 with respect to the lack of motivation to combine military and oilfield technologies applies to the Liu and Theis combination as well. Dr. Brooks even states that a person of skill in the art would understand that the military projectile technology taught by Theis would be useful in the oil and gas industry. But to support this proposition, Dr. Brooks relies on disclosures from the ’394 patent. This is a prime example of improper hindsight.

100. Dr. Brooks raises one additional argument that is not addressed in the sections above. Dr. Brook opines that at the time of the invention of the ’394 patent, there was a need for shaped charge liners that would both penetrate and provide an explosive jet. Thus a person of skill, according to Dr. Brooks, would look to the military technology disclosed in Theis. I disagree.

101. As an initial matter, this argument fails because Theis never even discusses a shaped charge. The mechanisms by which the Theis reference penetrates a target (a ballistic projectile) and the penetration mechanism taught by Liu (high-velocity metal jet) are very different. A person of skill in the art would not be motivated to look to Theis’ teaching to combine with reactive liner technology.

102. Moreover, the rationale set forth by Dr. Brooks still fails to address the problem that a person of skill in the art would not combine Liu’s metal-oxide reaction with Theis’ (and Fischer’s and Hardt’s) metal-metal reaction. It is only through hindsight that Dr. Brooks is able to make this logical leap. Even if the problems in Liu and Theis are “sufficiently similar”—which I do not agree as Theis’ goal is to create an incendiary effect, not a pressure and energy

release effect, after penetration—Dr. Brooks still fails to show how a person of skill in the art would combine these very different reactive technologies.

103. Thus, for the foregoing reasons, it is my opinion that Liu in view of Theis does not render obvious the asserted claims of the ’394 patent.

### 4.7 Liu in view of Becker Does Not Render the Asserted Claims Obvious

104. Finally, Dr. Brooks opines that Liu in view of Becker renders the asserted claims of the ’394 patent obvious. This combination was raised before the PTAB in Dyna’s ’394 IPR and was rejected. For the same reasons as stated above in Sections 4.5 and 4.6, as well as the reasons that military and oilfield technology would not be obvious to combine as outlined in Section 4.1 through 4.4, it is my opinion that Liu in view of Becker does not render obvious the asserted claims of the ’394 patent.

105. In addition to the above mentioned reasons, the disclosure in Becker is even further removed from the stated purpose of Liu. Becker discloses a reactive material—not a reactive liner—that is packed inside the nose of a projective and initiated while the projectile is in the air. The goal of Becker is to form a solid reactant while the projectile is in flight such that when the projectile hits its target, “the high temperature brittle solid material 34 [] disintegrate[s] into a pattern of hot fragments which can be distributed throughout the large volume of the energetic material sought to be destroyed.” Becker at 6:15-17. That is, Becker causes the reaction before hitting its target and then inserts the reactants into the target for purposes of deflagration or detonation.

106. The teachings in Becker are far removed from those in Liu. Setting aside the fact that the actual mechanics of the two reactions are widely different and that a person of skill would not be motivated to combine the references for that reason alone, a person of skill would realize that the purposes and mechanisms of Liu and Becker are very different. The goal of Liu is to

cause an exothermic reaction in the formation, releasing heat and pressure. Becker would cause the exothermic reaction (using a different metal-metal mechanism) before entering the target with the goal of spaying hot solids all throughout the target. The purpose of Becker would have no use in the oilfield perforating context. Thus, a person of skill in the art would not be motivated to combine the references.

107. For these reasons, the combination of Liu in view of Becker does not render obvious the asserted claims of the ’394 patent.

### 4.8 “Other Combinations”

108. Dr. Brooks reserves the right to rely on other, non-disclosed combinations of all of the above mentioned references. No other combinations other than Liu in view of Fischer, Liu in view of Theis, and Liu in view of Becker were disclosed in Dyna’s Invalidity Contentions. I understand that Dyna may not be entitled to use many of the other combinations relied upon in Dr. Brooks’ report. I further understand that Dr. Brooks may be limited in his ability to offer even more combinations. I have not performed an exhaustive review of combinations not specifically presented in Dr. Brooks’ report. Nevertheless, generally speaking, it is my opinion that any combinations of the cited references would fail for the many of the same reasons stated above. To the extent Dr. Brooks provides additional obviousness combinations, I reserve the right to address those by way of a supplemental report.

### 4.9 Secondary Considerations of Non-Obviousness

109. It is my opinion that several secondary considerations of non-obviousness support a finding of non-obviousness of the ’394 patent over the cited references. I have reviewed deposition testimony and relevant evidence, and I have spoken with Mr. Hardesty and Mr. Clark, and I have reviewed their witness statements provided in the UK litigation. Based on my review

of the evidence and my discussions, it is my opinion that the invention of the '394 patent has enjoyed much commercial success.

110. It is my opinion that CONNEX practices the '394 patent. The invention of the '394 patent allows CONNEX to produce a highly exothermic secondary reaction between nickel and aluminum upon detonation of the shaped charge. I understand from my discussions with Mr. Hardesty and Clark that CONNEX has enjoyed significant commercial success. I have reviewed documents showing that CONNEX has enjoyed increasing revenue and sales. *See* GEOD3_002313. I have also reviewed the report of Paul Benoit. Information in Mr. Benoit's report further supports my opinion that CONNEX has achieved commercial success. As explained in my opening report, it is also my opinion that DPEX uses the invention of the '394 patent. Fig. 17 of Mr. Benoit's report shows that DPEX has also achieved commercial success.

111. Dyna's own witnesses have testified that CONNEX has been commercial successful. Mr. McNelis testified, for example, that both DPEX and HaloFrac have been commercially successful. September 27, 2016 Deposition of Liam McNelis at 52. David Wesson agrees that CONNEX has been a commercially successful product. August 23, 2016 Deposition of David Wesson.

112. Dr. Brooks opines that the commercial success of CONNEX can be attributed to other factors. For example, Dr. Brooks believes that some of CONNEX's commercial success is due to marketing. While I agree that marketing may play a role in commercial success, CONNEX is marketed as a reactive shaped charge—a feature that is enabled by the invention of the '394 patent. It is my opinion that the commercial success of CONNEX cannot be attributed solely to marketing and that the commercial success of CONNEX shows that the reactive liner technology embodied by the '394 patent is not obvious.

113. Dr. Brooks also points to Mr. Clark's testimony to support his opinion that the commercial success of CONNEX is not due to the invention of the '394 patent. I disagree with Dr. Brook and disagree that Nathan Clark's testimony supports this position. As Mr. Clark explained, what was provided to him "could not be turned into a commercial project initially." Clark Depo at 70-71. Rather, it was the stated purpose of Mr. Clark's job to develop a commercially viable product using the reactive liner technology embodied in the '394 patent. Simply because it took work to develop a commercial product does not mean that the commercial success of the product is not attributable to the '394 patent. Rather, it is my opinion that the reactive liner technology of the '394 patent, that was incorporated into the CONNEX charge through Mr. Clark's efforts, is responsible for much of the CONNEX charge's commercial success.

114. Mr. Kirkpatrick's testimony is also consistent with the commercial success of CONNEX. According to Dr. Brooks, Mr. Kirkpatrick testified that customer of CONNEX purchase the charge based on whether it improves production of oil or natural gas from wells, not based on a reaction between two metal elements. But it is the reaction that is enabled by the '394 patent that allows CONNEX to improve shaped charge performance in various formation types. Similarly, while I understand that quality assurance plays a role in the ***quality*** of GEODynamics' CONNEX charge, and that customers appreciate the quality, the value of the CONNEX product is not derived solely from QC. Indeed, if there was fantastic QC on a product that did not work or was not useful, the product would not have commercial success. The fact that CONNEX uses the reactive liner technology from the '394 patent enables it to improve well performance and productivity and drive the product's commercial success.

115. I further disagree with Dr. Brooks' opinion that, because CONNEX is employed in a particular way, the commercial success of CONNEX cannot be attributed to the '394 patent. Similarly, just because other inventions contribute value to CONNEX does not mean that the invention of the '394 patent does not contribute value to CONNEX. Nevertheless, CONNEX is marketed as a reactive shaped charge. The reactive aspect of CONNEX is embodied in the '394 patent. It is the charge's reactive capabilities that, in my opinion, are causally related to the commercial success of CONNEX.

116. Another secondary consideration that supports a finding of non-obviousness is the industry skepticism of using reactive shaped charges for oil and gas perforation. Dr. Brooks opines that the '394 patent is invalid over Delacour and Wade. But both those references relate to the "Crack-Jet" titanium reactive charge commercialized by Schlumberger in the late 50s and early 60s. I understand that the Crack Jet charge was not a successful charge. Further, even though Wade touts the benefits of the Crack Jet charge, I understand that the images in Wade show that the charge actually does not perform well. It is not surprising that Schlumberger would come out with a paper touting the benefit of Crack Jet, as it is one of their charges. Nevertheless, a person of skill in the art would understand that there was significant skepticism in the industry relating to reactive shaped charges for oil and gas perforation.

117. Some of the industry skepticism is further detailed in papers published by Schlumberger and Halliburton. The Schlumberger SPE 121931 paper, entitled "Flow Performance of Perforation Tunnels Created With Shaped Charges Using Reactive Liner Technology," concluded that "reactive liner shaped charges appear to be detrimental to the flow performance of a naturally perforating completion." GEOD_02531 at 02534. I have discussed this paper with Mr. Clark and Hardesty and they agree that this paper created a great deal of

industry skepticism regarding the effectiveness of reactive liner shaped charges. Dr. Brooks contends that this paper does not show industry skepticism because Schlumberger had patented its own competing product. While this may be true, it does not change the fact that this paper caused much industry skepticism regarding the effectiveness of reactive shaped charges. In addition, this Schlumberger paper explains that, with respect to the old Crack Jet charge, there are "no known field or laboratory evidence [that] exists from these early days which would attest to the effectiveness of reactive liner technology in natural produces." *Id*.

118. Halliburton also promulgated papers that caused much industry skepticism. SPE 125752, entitled "A Comparative Assessment of 3 3/8 -in. Perforators Using 'Reactive' and 'Non-reactive' Shaped Charges," concluded that there was no statistically measurable advantage in using reactive shaped charges. GEOD_125939. The paper instead found that flow performance was better with conventional charges. I have spoken with Mr. Hardesty and Mr. Clark about this paper and I understand that SPE 125752 also contributed to a great deal of industry skepticism. Dr. Brooks discounts SPE 125752 because it did not test the charges in rocks and pressure conditions that had proved challenging to conventional charges. I disagree that this softens the negative effect this paper had in the industry with respect to the performance of reactive charges.

119. Moreover, Halliburton followed up its negative report with a presentation at OTC in 2010. GEOD_03073. The presentation states that the "reactive perforators did not penetrate the rock core targets as well as the conventional baseline perforator." *Id*. at 12. The presentation actually called out the reactive liner technology as detrimental to the shaped charge: "The addition of the reactive feature in the design of the charge has apparently sacrificed jet tip velocity." *Id*. at 9. The presentation concluded that there was "no statistical advantage" of

reactive charges in Berea Sandstone tests over a conventional charge. *Id*. In general, the presentation found that reactive charges were either not statistically better or statistically worse than conventional charges. Dr. Brooks opines that the presentation showed that "Reactive Charge D" outperformed the conventional charge at a very specific condition. However, the paper is clear that the reactive charge's slight outperformance is "not statistically significant with a 95% confidence level." In short, OTC 20893 discourages the use of reactive charges in any conditions and, based on my conversations with Mr. Hardesty and Mr. Clark, resulted in significant industry skepticism.

120. Dr. Brooks also opines that the Halliburton and Schlumberger articles were published after the date of invention. I understand that the industry skepticism consideration seeks to evaluate skepticism, disbelief in, or incredulity on the part of those skilled in the art that the patentee's invention worked. I further understand that secondary considerations are not confined to when the invention was made. Rather, to evaluate skepticism of the invention, one needs to wait for the invention to be made. It is my opinion that the Schlumberger and Halliburton references cited above show that the industry had significant doubt that the invention of the '394 patent actually worked. And indeed, the evidence supports that the Schlumberger and Halliburton skepticism caused industry-wide skepticism of reactive shaped charges. *See, e.g.*, GEOD_13356; GEOD_117969; GEOD_13375; GEOD_60305.

121. It is also my opinion that there was a long-felt but unresolved need for the invention of the '394 patent. As detailed in the Delacour and Wade references, as far back as the late 50s, there was a recognition that materials in the perforation tunnel could hamper production. It was also well understood in the industry that perforation in overbalanced conditions was undesirable. As explained in Mr. Hardesty's UK witness statement, the use of underbalanced formation was

primarily used in order to remove the debris caused by non-reactive shaped charges. However, the majority of wells in the United States exist in overbalanced, rather than underbalanced conditions. Thus, there was a long-felt need to develop a technique to perforate wells in overbalanced conditions. Moreover, the industry skepticism of the effectiveness of shaped charges in overbalanced conditions, and the ultimate success of CONNEX in overbalanced conditions, shows unexpected beneficial results of the '394 patent and further supports non-obviousness.

122. Dr. Brooks opines that he is "not aware of anyone purchasing ConneX (or any other reactive shaped charge) based on any of the claim limitations in the '394 patent." Dr. Brooks cites no evidence to support this statement. Nevertheless, I disagree. Based on my discussion with Mr. Hardesty and Mr. Clark, my review of their witness statements, and my review of the evidence in this case, it is my opinion that customers purchase CONNEX because of its reactive capability. This reactive capability results in improved well performance. While a customer may not know that the charge is undergoing an intermetallic exothermic reaction to produce an intermetallic compound with an electron concentration of 1.5, the customer does know that the charge is reactive and that it works. The reason behind CONNEX's reactive characteristic and, ultimately, improved flow performance, is the invention of the '394 patent.

123. The fact that DynaEnergetics promptly followed GEODynamics to market also supports non-obviousness. Specifically, Dyna has testified that GEODynamics' decision to go to market with the CONNEX charge "influenced the decision to move ahead and push forward with commercializing our DPEX charge." McNelis Depo at 194. This shows that Dyna immediately realized the unique nature of the CONNEX charge and quickly decided to join untapped market.

124. Finally, the ultimate recognition of the ’394 patent’s advancement over the prior art by technically competent peers weighs in favor of a finding of non-obviousness. I understand from my conversation with Mr. Clark and my review of his UK witness statement that Mr. Clark was approached by BP to use the CONNEX charge in the “Thunder Horse” well, an overbalanced well in the Gulf of Mexico. Up until that time, I understand that the “Thunder Horse” platform had not been not been successfully perforated and was considered abandoned due to lack of flow. I understand that CONNEX was tested prior to use in “Thunder Horse” and that the tests performed by Schlumberger in connection with BP showed the CONNEX charge produced amazing results. Eventually, the charge was used in the “Thunder Horse” well. As a result of CONNEX’s use, the “Thunder Horse” well began to perform above expectations. GEOD_231673; GEOD_12191. After this successful real-world trial, the CONNEX charge embodying the ’394 patent began to become accepted in the industry.

125. For these reasons, it is my opinion that secondary considerations of non-obviousness support a finding that the ’394 patent is not obvious in view of the references asserted against it by Dr. Brooks.

## 5. The Asserted Claims are not Invalid Under 35 U.S.C. §112(1)

### 5.1 There is Sufficient Written Description Support for “Respective Proportions”

126. Dr. Brooks opines that the asserted claims of the ’394 patent are invalid for lack of written description because the inventors of the ’394 patent did not have possession of ratios of nickel and aluminum that produce trivial amounts of NiAl. Dr. Brooks states that he “understand[s] from counsel for DynaEnergetics that GeoDynamics nevertheless may argue that the ‘respective proportions’ limitation is satisfied by a nickel-aluminum liner that produces only trivial amounts of NiAl upon detonation of an associated shaped charge.” Brooks Report at ¶

146. It is unclear what Dr. Brooks means by "trivial amounts of NiAl." In my opinion, the term "trivial amounts" injects more vagueness into the term than necessary.

127. Dr. Brooks' opinion seems to make little sense in light of the Court's claim construction ruling. Dr. Brooks opines that "[t]he Court did not provide specific guidance for identifying non-stoichiometric quantities satisfying the 'respective proportions' limitation." Brooks Report at ¶ 145. But the Court specifically held that "additional guidance is not required given the context of the claim." Claim Construction Ruling at 34 (Dkt. No. 82). The Court instead ruled that "[i]f a reactive shaped charge liner is activated, and an intermetallic product with an electron concentration of 1.5 is formed, it will necessarily have the respective proportions necessary to yield such as reaction." *Id*.

128. Dr. Brooks opines that the Court rejected GEODynamics' argument "that any combination of nickel and aluminum will meet the 'respective proportions' limitation." Brooks Report at ¶ 146. But Dr. Brooks takes this to mean that the Court rejected an argument that any combination of nickel and aluminum that produces any amount of NiAl (or other intermetallic compound with electron concentration of 1.5) meets the "respective proportions" limitation. This is not what the Court held. The full context of the Court's order makes clear that the Court rejected the argument that the claims cover any amount of nickel and aluminum to the extent only intermetallic products not covered by the claims are formed:

> Defendant argues that the patent provides no guidance as to what additional ratios and mixtures may qualify beyond stoichiometric quantities. (Dkt. No. 60 at 23). The Court finds that additional guidance is not required given the context of the claim. If a reactive shaped charge liner is activated, and an intermetallic product with an electron concentration of 1.5 is formed, it will necessarily have the respective proportions necessary to yield such a reaction. That said, the Court rejects the argument that any combination of Ni and Al will satisfy the limitation, as Plaintiff's expert suggests. (Dkt. No. 59-10 at 94:14–18) ("Q.· ·And that's my point.· So under your reading, your interpretation of this patent, every combination of nickel and aluminum is covered? . . . A.· ·Yes.). This interpretation would render the "respective proportions" term meaningless because it would cover any proportions and any electron concentration. Indeed, the '394 Patent unambiguously disavows a number of reactive metal combinations, including $Ni_2Al$, as not covered by the claimed invention. '394 Patent at 7:36–40.

Claim Construction Ruling at 34.

129. I therefore disagree with Dr. Brooks' opinion that the Court's claim construction is unclear as to what respective proportions of nickel and aluminum are covered by the claims. It is my opinion that "[i]f a reactive shaped charge liner is activated, and an intermetallic product with an electron concentration of 1.5 is formed," the respective proportions limitation of claims 1 and 28 will be satisfied.

130. It is my opinion that there is written description for respective proportions that produce an intermetallic product with an electron concentration of 1.5 upon activation of the shaped charge. It is unclear whether Dr. Brooks agrees that the Court's construction is supported by the specification. What is clear is that Dr. Brooks argues, to the extent the claims of the '394 patent encompass ratios of nickel and aluminum that produce only trivial amounts of NiAl, those claims fail to meet the written description requirement of 35 U.S.C. §112(1)." Brooks Report at ¶ 153. As explained above, I believe the Court has already addressed this issue. Further, Dr.

Brooks' definition of "trivial amounts" is unclear. Nevertheless, I believe that there is sufficient written description support in the specification for Court's construction.

131. Dr. Brooks seems to focus his analysis on what the inventors "endeavored" to create, or what the specification details as the stated purpose of the patent. But that is not the standard for written description. I understand that written description is satisfied if a person of skill in the art at the time of the invention would understand that the specification conveys with reasonable clarity that the inventor was in possession of the invention as claimed.

132. The specification of the '394 patent explains that, although stoichiometric ratios may be preferred, "ratios other than a stoichiometric ratio may also afford an exothermic reaction and as such the invention is not limited to stoichiometric mixtures." '394 patent at 3:48-51. The '394 patent's specification says that the primary aspect of the invention relates to "a composition capable of an exothermic reaction upon activation of the shaped charge liner." *Id*. at 57-60. The specification goes on to describe that "[t]he liners give particularly effective results when the two metals are provided in respective proportions calculated to give an electron concentration of 1.5, that is a ratio of 3 valency electrons to 2 atoms such as NiAl or PdAl." Note that this is nearly identical language to the language of the claims.

133. Based on these disclosures, it is my opinion that a person of skill in the art at the time of the invention, upon reading the specification, would understand that the inventor of the '394 patent had in his possession the invention of a reactive liner composition that creates an intermetallic compound with an electron concentration of 1.5 (such as NiAl) upon detonation of the shaped charge. A person of skill in the art would understand that the inventor of the '394 patent had in his possession the invention of making any amounts of NiAl. Indeed, if one could create significant amounts of NiAl based solely on the composition of the liner, one would

necessarily be able to make small amounts of NiAl by altering the liner blend. A person of skill in the art at the time of the invention would understand this and would understand that the inventor had in his possession a liner composition that formed, in any amount, an intermetallic product with an electron concentration of 1.5 upon activation of the shaped charge.

134. Therefore, it is my opinion that there is sufficient written description support for the scope of the "respective proportions" limitation as defined by the Court.

### 5.2 There is Sufficient Written Description Support for "Further Inert Metal"

135. I understand that DynaEnergetics has retained Tod Tumey in this case to offer certain expert opinions regarding whether the '394 patent offers sufficient written description support for the "further inert metal" limitations. Specifically, I understand that Mr. Tumey has opined that to the extent the '394 patent encompasses "nickel-aluminum liners with high amounts of tungsten (*i.e.*, at least 40% w/w), the '394 patent would be "invalid for failing to meet the written description requirement. Tumey Report at ¶ 106.

136. It is my opinion that the '394 patent provides sufficient written description support for the "further inert metal" limitation. The written description of the '394 patent allows persons of skill in the art to recognize that the inventors of the '394 patent had invented what is claimed. Further, it is my opinion that Mr. Tumey has failed to demonstrate the inventors of the '394 patent did not have possession of the patented invention of the asserted claims at the time the '394 patent was filed.

137. I have reviewed the '394 patent to evaluate whether the written description of the patent provides adequate support for the "further inert metal" limitation. It is my opinion that the full breadth of the asserted claims containing the "further inert metal" limitation, as construed by the Court, is described and supported in the specification. The scope of the claimed invention is commensurate with the '394 patent's disclosure. A person of skill in the art would understand

that the inventors of the ’394 patent were in possession of a reactive shape charge with a reactive liner comprising a “further inert metal,” as construed by the Court.

138. The 394 patent’s specification discloses a reactive shaped charge liner comprising at least one further inert metal that is not capable of an exothermic reaction. In fact, the specification plainly states that “[i]n an alternative arrangement it may be desirable that the liner further comprises at least one further metal, where the at least one further metal does not participate in the exothermic reaction when the shaped charge is activated.” ’394 patent at5:43-46. The ’394 explains that the further inert metal “may be selected from any commonly used or known shaped charge liner metal,” including, for example, tungsten. *Id*. at 5:47-52.

139. The specification of the ’394 patent goes on to demonstrate the inventors’ familiarity with the properties of inert metals like tungsten, stating that such metals are “commonly used or known shaped charge liner metal[s].” *Id*. at 5:46-47. The inventors also explain that a person of skill in the art would understand that inert metals, like tungsten, are included in the liner to “provide additional mechanical strength to the liner and thus to increase the penetrative power of the jet.” *Id*. at 5:49-51. Further underscoring the inventors’ familiarity with inert metals is the observations that “[t]he properties of tungsten and copper as shaped charge liners are well known and they are typically used as liner materials due to their high density and ductility, which traditionally make them desirable materials for this purpose. *Id*. at 5:51-55.

140. In view of the “mechanical strength,” “high density,” and “ductility” of the traditional inert metals known to those skilled in the art, such as tungsten, the inventors of the ’394 patent explained that “it may further be desirable to incorporate a portion of either copper or tungsten or an alloy thereof, into the reactive liner of the invention in order to provide a reactive liner of increased strength and hence a more powerful jet.” *Id*. at 5:55-59. This disclosure highlights the

inventors' understanding that the power of the jet is tied to the inclusion of an inert metal in the liner. Finally, the inventors disclose a preferred embodiment of the reactive liner in which the liner includes two layers, in which the inner layer is made from the at least one further inert metal, and the outer layer is a reactive liner composition. *Id*. at 5:59-64. The two-layer embodiment of the claim demonstrates the inventors' possession of a reactive liner in which the *entire* inner layer is comprised of one or more inert metals.

141. As a person of skill in the art, I understand this disclosure demonstrates the manifest that the inert "portion" of the liner is absolutely critical to the strength, power, and effectiveness of the patented shaped charge. Contrary to Mr. Tumey's assertions, nothing in the '394 patent's specifications suggest that the inventors were in possession of only reactive liners with relatively low amounts of inert metals. In fact, these disclosures highlight the critical benefits of inert metals—tying the liner's strength and the jet's power to the inclusion of inert metals.

142. In explaining how the inventors' of the '394 patent allegedly lacked possession of reactive shaped charge liners with at least 40% tungsten, Mr. Tumey explains that he considered "existing knowledge in the particular field [and] the scope and content of the prior art." Mr. Tumey evidently appears to have overlooked the fact that Brian Bourne, named inventor on the '394 patent, was well-aware of shaped charge with more than 40% tungsten. Tumey Report at ¶ 110. For example, U.S. Patent Application 2004/0255812, on which Mr. Bourne is a named inventor, explains:

> "It is well known that penetration depth is proportional to $(jet\ length)\ x\ (density\ ratio\ of\ liner\ material)^{1/2}$. Therefore, increasing density of the liner material will increase the penetration depth of the jet. Tungsten has a high density and so by using a liner that comprises greater than 90% by

> weight tungsten the penetration depth is improved over prior art liners, particularly in the oil and gas industry.[3]

143. It is my opinion that a person of skill in the art in the field of shaped charges in the oil and gas industry would understand the properties of inert metals such as tungsten, and would understand the relevant benefits and drawbacks of increasing or decreasing the relevant portions of inert metals in the reactive shaped charge liner claimed in the '394 patent. The properties of inert metals, such as tungsten, were well known in the field in the time of the invention of the '394 patent. And the characteristics of these metals, including density, ductility, and mechanical strength were both well-known and predictable.

144. I agree with Mr. Tumey that, with respect to inert metals, the claims of the '394 patent are commensurate with the disclosure of the '394 patent, insofar as both the claims and the specification disclose a further inert metal, but neither the claims nor the specification place a limit on the specific percentage of inert metal that may be included in the reactive shaped charge liner.

145. I disagree with Mr. Tumey that the fact that Mr. Bourne later filed the '563 patent demonstrates that the '394 patent lacks sufficient written description under 35 U.S.C. § 112(1). While it's true that Mr. Bourne is a named inventor on the '563 patent, Leslie Raymond Bates is not. The '563 patent therefore comprises a different inventive entity and is unrelated to the '394 patent. Moreover, the mere fact that the '563 patent recites testing information supporting strong and even surprising performance of a 70% tungsten reactive liner does not impact the scope of the disclosure of the '394 patent.

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[3] U.S. Patent Application No. 2004/0255812 is cited on the face of the '394 patent.

146. I disagree with Mr. Tumey's characterization of the '563 patent's disclosure. Specifically, I disagree that it "effectively state[s] that the inventors on the '394 patent were not in possession of high-tungsten liners." Tumey Report at ¶ 114.

147. I disagree that statements made by non-inventors, such as Mr. Church, during the course of the '563 IPR more than a decade after the filing of the '394 patent bear on the issue of whether the inventors of the '394 patent were in possession of their claimed invention.

148. I disagree with Mr. Tumey's suggestion that the fact that QinetiQ and/or GEODynamics did not physically test high-tungsten liners prior to October 2003 bears on the validity of the '394 patent. Tumey Report at ¶ 117. I understand that actual reduction to practice of the patented invention is not necessary to satisfy the written description requirements under 35 U.S.C. § 112(1).

149. Therefore, it is my opinion that there is sufficient written description support for the scope of the "further inert metal" limitation as defined by the Court.

**6. Inequitable Conduct**

150. I understand that DynaEnergetics has retained Mr. Tumey to offer certain expert opinions concerning the alleged inequitable conduct raised by DynaEnergetics in this case. Mr. Tumey's principal contention is that the applicants' submission of the Church Declaration and supporting testing data during prosecution of the '394 and '563 patents amounts to inequitable conduct. After reviewing the intrinsic records of the '394 and '563 patents, including the file histories, the deposition testimony of Mr. Church, and all other evidence cited by Mr. Tumey, it is my opinion that there was nothing improper or misleading about the use of the Church Declaration in the prosecution of both patents, because the Church Declaration is relevant to the patentability of both patents.

151. On August 8, 2011, the USPTO issued a non-final Office Action rejecting pending claims. On February 8, 2012, applicants filed a Reply to the August 8, 2011 Office Action. Attached to their Reply was the Declaration of Mr. Church, filed pursuant to 37 C.F.R § 1.132. The Church Declaration sets forth Mr. Church's qualifications, and describes certain experimental data submitted to the USPTO for consideration. The experimental data was submitted to the USPTO as Appendix 1 to the Church Declaration. The declaration states that the data was collected and submitted for the purposes of "evaluating the penetration performance of the perforator and the flow performance resulting from the penetrating event." Church Decl. at ¶ 5. Mr. Church further states that that the experimental data is "*related* to the performance of shaped charge perforators according to a *preferred aspect* of the claimed inventions, as recited in claim 47, and data relating to *comparative perforators*." *Id*. Mr. Church is very clear that the data set includes perforators having a "preferred aspect" of the claimed invention and comparative perforators, that evidently do not have the "preferred aspect" of the claimed invention.

152. As made clear in the following paragraphs in Mr. Church's declaration, the "preferred aspect" most germane to the prosecution of the '394 patent is the inclusion of certain reactive metals that are of "a particular class of reactive metals known as Hume-Rothery 3/2 compounds." Mr. Church then goes on to identify some exemplary Hume-Rothery 3/2 compounds, including NiAl. *Id.* at ¶ 6.

153. Mr. Church then explains that the experimental data related to the testing of Hume-Rothery compounds "demonstrates that shaped charge perforators comprising liners having nickel and aluminum as the reactive intermetallic alloying elements are highly advantageous" compared to other baseline charges. *Id.* at ¶ 8. Mr. Church then explains that the liners comprising nickel and aluminum "produce clean holes and repeatedly show a surprising and

unexpected 'expanded tip' phenomenon, which phenomenon was not observed in the trials for baseline charges." *Id.* at ¶ 9. Mr. Church's declaration makes clear that he is not representing to the USPTO that every single liner included in the experimental data set is an embodiment of the '394's claims. Moreover, the focus of Mr. Church's declaration and accompanying data is to demonstrate the efficiency of reactive shaped charge liners that form NiAl, as opposed to other liner compositions.

154. Mr. Church also explains that adding "at least one further inert metal" to shaped charges comprising nickel and aluminum "increased average flow performance" compared with baseline shaped charges. *Id.* at 10.

155. It is my opinion that the central focus of the Church Declaration and experimental data is to demonstrate the unexpected and superior results of reactive shaped charge liners comprising nickel and aluminum, as compared with liners with different compositions. For instance, Section 1.1-1.2 of the experimental data demonstrates that the inclusion of nickel and aluminum in a shaped charge liner—without the addition of *any* further inert metal—"produced a tunnel with a bulbous ("expanded") tip, clear of debris and with clearly defined walls." Mr. Church further explains that the NiAl perforator produced "a significant improvement over the baseline perforator in tunnel diameter and hole sizes….yielding "a hole volume that was 663% greater than the baseline." These results, which have nothing to do with the ratio of inert metals to reactive metals, support the patentability of the '394 patent.

156. I understand that DynaEnergetics and Mr. Tumey take issue with the inclusion of iterations 5 and 6 of Mr. Church's iterative testing, because those iterations involved liners comprising 70% tungsten. But even if iterations 5 and 6 were omitted from Mr. Church's iterative testing, the experiments would have still demonstrated the superior results of liners

comprising nickel and aluminum and liners comprising nickel, aluminum and tungsten (in amounts of 40% or less). In other words, regardless of whether iterations 5 and 6 embody the claims of the '394 patent, the iterative tests performed on iterations 0-4, which neither Mr. Tumey nor DynaEnergetics dispute are covered by the claims of the '394 patent, support the patentability of the '394 patent.

157. It is my opinion that the flow testing described in Mr. Church's experimental data cannot show provide a basis for DynaEnergetics' inequitable conduct claim. First of all, as Mr. Tumey agrees, the Court has not construed the "further inert metal" element in a manner that limits the amount of inert metal that may or may not be included in the reactive liner. Tumey Report at ¶ 105. Therefore, under the Court's construction, iteration 6 embodies the claims of the '394 patent. But even if iteration 6 did not embody the claims of the '394 patent, the inclusion of the flow testing does not satisfy the materiality element of an inequitable conduct claim. This is true for two reasons. First, Mr. Church attributes the enhanced flow performance of iteration 6 is clearly attributable to the inclusion of nickel and aluminum and the unique tunnel geometry caused by charges comprising nickel, aluminum, and one further inert metal. Church Declaration, App'x 1 § 4. These characteristics are not unique to iteration 6. Second, the flow-test analysis was not needed to establish the improved performance of the patented invention over shaped charges. Both the initial comparative tests and the iterative tests are sufficient to demonstrate surprising performance of certain aspects of the patented invention as compared to baseline shaped charges.

158. It is therefore my opinion that there is nothing false, fraudulent, or misleading about the Church Declaration and supporting experimental data submitted to the USPTO during the prosecution of the '394 patent.

159. I would further note that Mr. Church's conclusions simply had nothing to do with the percentage of tungsten included in the tested shaped charge liners. In fact, Mr. Church's ultimate conclusions for each of the three tests fails to even mention the relative amount of inert metal as a causal element of the results. For example, in concluding his observations, Mr. Church states that his results "show that shaped charge perforators comprising Ni-Al liners show an unexpected result 'expanded tip' effect when compared to liners comprising other Hume-Rother 3/2 intermetallic compositions, which is enhanced using Ni-Al liners comprising at least on further inert metal (in this case tungsten)." *Id.* Mr. Church then observes that "The perforators also produce significantly cleaner holes than baseline perforators, and the tunnel clean up is maintained for Ni-Al liners comprising at least one further inert metal." *Id.* Finally, with respect to the flow test, Mr. Church states the improved results are "thought to be an combined result if the reaction of the jet material and target and the unexpected 'expanded tip' geometry, which promotes more localized fractures in the tip region." *Id.*

160. I disagree with Mr. Tumey's characterization that Mr. Church's declaration that "he did not believe that all of the data he submitted to the PTO in the '394 patent prosecution related to embodiments of the claimed invention." In fact, the representation that Mr. Church made to the USPTO is that the "experimental data related to the performance of shaped charge perforators according to a preferred aspect of the claimed invention as recited in claim 47, and data relating to comparative perforators." Church Decl.at ¶ 5. In my opinion iteration 6 certainly relates to a preferred aspect of the claimed invention, insofar as it contains nickel and aluminum and one further inert metal.

161. Mr. Tumey's contention that Mr. Church mislead the USPTO be relying on iteration 6 is further undermined by the fact that Mr. Church testified under oath that he does not know

whether "a composition of 21 percent nickel, 9 percent aluminum, and 70 percent tungsten" is covered by the '394 patent. Church Depo. Tr. 90:7-91:20. This testimony, along with the protracted dispute concerning the proper scope of the '394 patent's "further inert metal" limitation demonstrates that Mr. Church did not submit an "unmistakably false" declaration to the USPTO.

162. Moreover, it is my opinion that the applicants' failure to expressly notify the USPTO that Mr. Church's experimental data had been disclosed during the prosecution of the '563 patent does not amount to inequitable conduct, because the experimental data supports the patentability of both patents. Specifically, in the context of the '394 patent, the experimental data demonstrates that the inclusion of nickel and aluminum provides superior performance and surprising results, and the inclusion of at least one further inert metal (in relatively low amounts or relatively high amounts) similarly enhances tunnel geometry and performance. In contrast, the data submitted during the prosecution of the '563 patent is relied upon to make an entirely different argument, namely that it was surprising to observe a decrease in clear tunnel percentage in charges up to 40% w/w tungsten followed by an increase at 70% w/w. Reply to Office Action, July 23, 2013, at 4-6. This argument was not made during the prosecution of the '394 patent, as it was not material to the patentability of the '394 patent—which is silent on the relative portions of inert metal included in the reactive liner.

163. It is my opinion that the data submitted during the prosecution of the '394 and '563 patents supports the patentability of both patents, and therefore, DynaEnergetics cannot demonstrate that the applicants of those patents engaged in inequitable conduct.

164. It is my opinion that Mr. Tumey has not demonstrated that QinetiQ acted with the requisite intent to deceive. As explained above, the data submitted in both prosecutions

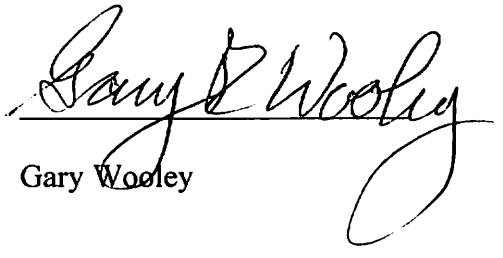
addressed unique issues of patentability concerning both patents. With respect to the ’394 patent, the data highlighted the benefits of using nickel and aluminum in a reactive shaped charge liner as well as using a further inert metal in combination with the nickel and aluminum in a reactive shaped charge liner. In contrast, the data demonstrated the results on in TCP value and %CT when comparing the *percentages* of inert metal included in the charges—an element not included in the claims of the ’394 patent. Furthermore, I disagree with Mr. Tumey’s conclusion that the “single most reasonable inference to be drawn” from the facts at issue is that QinetiQ tried to conceal the ’563 patent prosecution from the examiner of the ’394 patent. Moreover, none of the facts set forth in Mr. Tumey’s report amount to “egregious conduct.”

165. It is my opinion that even if QinetiQ had disclosed the existence of the ’563 application during the prosecution of the ’394 patent, the ’394 patent would still have issued. Specifically, the use of the experimental data in the ’563 patent prosecution does not alter the fact that the written description of the ’394 patent supports the full breadth of the claims.

166. I reserve the right to supplement or amend this report as necessary or appropriate to take into account additional information obtained through discovery or otherwise. I also reserve the right to supplement or amend this report as necessary or appropriate to the extent that the Court modifies any of its claim constructions as reflected in its Claim Construction Order. Furthermore, in support of the discussion and the opinions given above, I would expect at trial to rely upon demonstratives or exhibits that may consist of copies of the documents referenced or portions thereof (or of documents cited or relied upon by other experts in this case), and may also rely upon charts, graphics, animations or slides designed to summarize or illustrate the background of the technology and the basis for my opinions.

167. I may also create or assist in the creation of certain demonstrative exhibits that rely on analogies concerning the differences between the Patents-in-Suit and the references identified in Dr. Brooks'. Among other things, I may use portions of prior art documents or of the patents themselves. I may also rely upon graphics or an animation, similar to the tutorials presented to the Court during the *Markman* phase of this case, in presenting a tutorial to the jury. Finally, I expect that certain documents used as exhibits may be enlarged, highlighted or otherwise emphasized for use as exhibits during trial. I have not yet selected or created the particular exhibits that might be used.

Executed on June 22, 2018



Gary Wooley

## MATERIALS CONSIDERED

I have reviewed all materials cited in my infringement expert report, this expert report, and appendices. In my expert report, including my appendices, I may cite to particular pages of documents, deposition transcripts or other materials; however, in forming the opinions in my expert report, I have relied on the documents, deposition transcripts or other materials generally, and not only the particular pages cited.